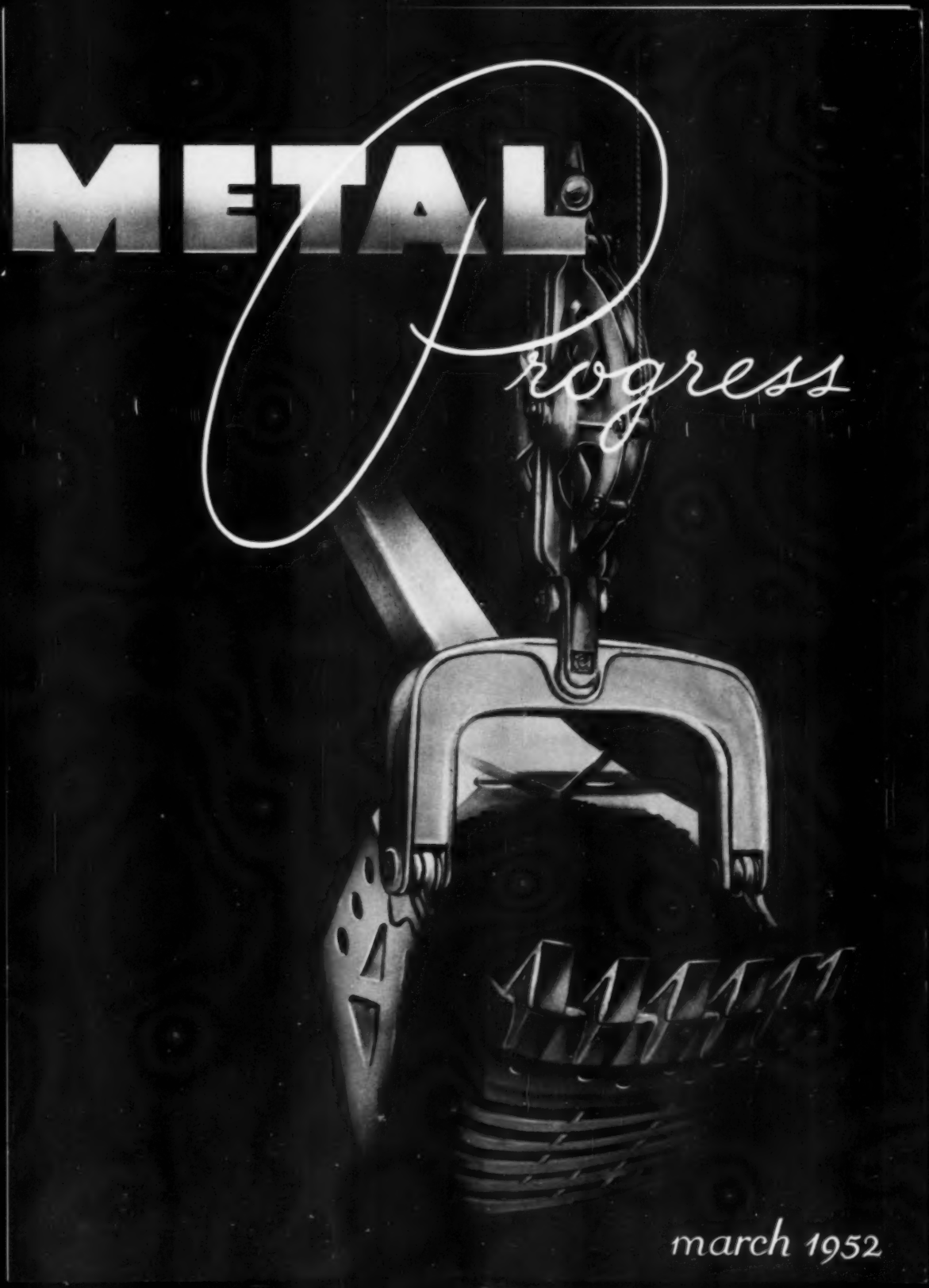
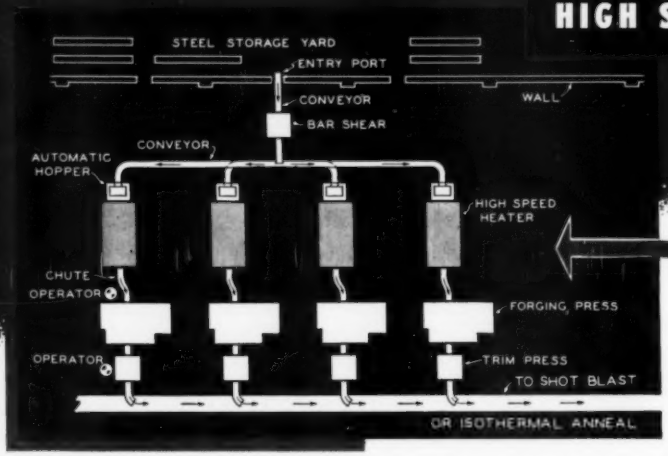
METAL Progress



march 1952

YOU'LL FORGE IN THE FUTURE *Automatically...*

WITH 'SURFACE' HIGH SPEED HEATING



NOTE 'SURFACE' AUTOMATION *in this 'Surface' High Speed Heating installation in a forge shop of the future.*

YOU'LL HEAT PIECES UNIFORMLY AND AUTOMATICALLY from billet to billet with automatic cycles in a 'Surface' High Speed Heating Furnace. What's more, you'll produce more forgings in the same space with less manpower.

● The forging plant is ripe for mechanization. 'Surface' High Speed Heating furnaces, already proved with bright performance records, help speed automation in production forging plants. Here's why:

'Surface' High Speed Heating means fewer pieces at temperature at one time. This permits close control of the work. Decarburization and grain growth are retarded; cleaning and machining costs are reduced with less embedded scale in the surface of the forging.

'Surface' High Speed Heating improves die life because of extremely thin scale, increases utilization of press equipment.

Automation with 'Surface' High Speed Heating means space requirements 1/4 to 1/3 those of conventional methods; plus a labor savings through automatic handling that ties in efficiently with automation elsewhere in the line.

More descriptive data on the high speed combustion system, the furnace unit, application, and comparative costs are available at your request.

THERE'S ECONOMY IN GAS!

Electricity	@ .0125c per KWH, $5.00 per Ton heated.
Oil	@ 70c per million Btu, $4.60 per Ton heated.
Gas	@ 47c per million Btu, $2.50 per Ton heated.

Write Today for Bulletin SC-144

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

'Surface' INDUSTRIAL FURNACES

IN THIS ISSUE

Atomic power

The general problem 70
Liquid sodium for "steam" 71

Advanced foundry practice

A forward look 65
Big bronze casting 76
Gypsum-sand molds 51
Resin binders for sand 126

Corrosion control

Review of recent progress 82
Chromizing the surface 118
Aluminized steel 150

Plating and finishing

White brass plate 61
Notes on grinding wheels 53
Structure of electrodeposits 106

High-temperature alloys

Methods of appraisal 55
"Sweat-cooled" turbine blades . . . 81
New super-alloys 127
Creep of austenitic alloys 156

Fabrication

Lubrication at cutting tool 52
Welded monoframes 79

Properties of alloys

Beryllium-copper 80-B
Impact fracture 79
Hydrogen in low-alloy steels 114

RETURN YOUR SCRAP

BRASS MILLS MUST HAVE IT TO MAKE MILL PRODUCTS

Table of Contents — p. 49

New Products — p. 17

Advertisers' Index — p. 184

Flip the Flap

As I was saying—

IT IS A DELIGHT to read the letters from the overseas conferees to the World Metallurgical Congress. Here are brief extracts from a few:

Express my personal appreciation for all that A.S.M. did for members of the W.M.C. It was undoubtedly a great success. . . . It will ever be held as a monument to A.S.M.'s foresight and energy. . . . The conferees will always treasure happy memories of the kindness and hospitality. . . . As I ponder on the great things it has achieved. . . . It was a grand privilege to have as friends for the rest of my life. . . . As years go by, new friendships made between people of widely separated nations will prove to be the greatest achievement of all. . . . Trust time will not be long before another W.M.C. enables the refocusing of these friendships and the making of new ones. . . . All the visits have been wonderful. . . . Learned more than I had ever expected. . . . Saw so many things and I got so much information that my technicians are in one word astonished about it. . . . Initiative to bring technicians from Europe together has given great impulse to the co-operation of many West European countries. We are looking forward how to continue this for the future. . . . Will never forget this wonderful trip. . . . Opportunity to know and appreciate the reception and kindness of the American people, thanks to W.M.C. . . . I have many new friends. . . . The very friendly atmosphere contributed . . . success . . . phenomenal metallurgical convention. . . . Will help bring these countries to the best relations with the U.S.A. . . . Come to Europe so that I can give back something of all that you gave me. . . . Most important thing was to learn the American Way of living. . . . I shall always remember the "Study Tour at Sunnimoor Farm" with greatest pleasure, one of the peak events of the trip. . . . Proud to tell what we have seen and heard in your great and wonderful country. . . . The great mass of intelligent people are deeply appreciative of the good feeling between our two countries and the real help so unselfishly given to us by the U.S.A. Please do not judge us by a few of our people with warped minds who pander to the few with communist leanings. . . . I am indebted to all who took part in this history-making event. . . . Created lasting bonds of friendship among individuals of the free world. . . . Help in our efforts to increase productivity of our factories and the rearmament of the free world. Milestone in the progress toward a better understanding between freedom-loving people for world peace. . . . Profound effect upon each of the foreign conferees. . . . Pleasing experience. . . . Satisfying feeling. . . . Vast amount of good accomplished in fostering better understanding among the free peoples of the world. . . . "Well done". . . . One of the most important periods of my life. . . . The associations, the friendships, the exchange of views, the meeting of minds, the mental stimulation—and more comes to my mind. . . . The experience was exhilarating and will live with me forever. . . . Saw America at work. It should pay off for years to come. . . . Will leave a beneficial effect upon the A.S.M., the metallurgical and industrial world and international peace for many years to come. . . . To meet with the great and generous American people and with great family of A.S.M. . . . Fine memories. . . . Has done more for the reconciliation of nations than a great number of conferences of the U.N. . . . I would not let go back the year 1951 to the eternity from whence it came without saying to the A.S.M. personally my sincere thanks. . . . We would like to show our American friends our European steel works. . . . Left hospitable America as friends. . . . Deeply impressed by the technical progress and the great love for freedom. . . . The consciousness of having done work of such grandeur and supreme importance may let you feel great satisfaction. . . .

The last extract surely expresses the feelings of all members of the A.S.M. We all are happy to have had a part in the World Metallurgical Congress.

Cordially yours,

Bill

W. H. EISENMAN, *Secretary*
American Society for Metals

THERMALLOY "30"

A cast heat-resistant alloy with high aged ductility

For service in the 1200°-1600°F. range

WRITE FOR NEW FREE FOLDER

Thermalloy* "30"—a 21% Cr 9% Ni alloy—has outstanding aged ductility characteristics and hot strength equal to that of 25% Cr 12% Ni type alloys. Since its alloy content is lower, Thermalloy "30" is also somewhat more economical.

In tests involving over 100 heats, excellent data has been obtained on stress rupture properties, aged ductility, oxidation resistance and mechanical properties. For additional information write for Bulletin T-211. Electro-Alloys Division, 2093 Taylor St., Elyria, Ohio.

THERMALLOY "30" OFFERS:

Improved Ductility— 18% minimum after aging for 24 hours at 1400° F.

Uniform Strength Levels— equivalent to and more uniform than 25% Cr 12% Ni types.

Greater Economy— since quantity of alloying elements is less than in similar types.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

A Statement by Anaconda on the Copper Situation

MANY users of copper have vital decisions to make . . . usually in connection with the present defense-induced shortages of copper and aluminum. This statement is an effort to remove the smoke screen surrounding the copper picture . . . to wipe away the confusion caused by too much talk supported by too few facts.

Substitution poses problems – Industry has been urged to substitute aluminum and other materials for copper. In some instances this may be logical and practicable. In many others it is difficult, if not impossible. But – before making *any* long-term decisions that may cost a great deal of money in engineering, new plant facilities or rescheduling of production operations – one should know the facts about the future of copper.

New Anaconda projects – The first major increase in copper production will come from Anaconda when the Greater Butte Project and the new Sulphide Plant at Chuquicamata, Chile, begin operations this spring. By 1953, these two projects should raise present levels of copper production by about 95,000 tons yearly.

Toward the close of 1953, Anaconda's new Yerington project in Nevada is expected to start producing at an annual rate of 30,000 tons. By then, Anaconda will be adding to the present yearly copper supply at the rate of about 125,000 tons.

Other new projects – During 1954-55 still other new projects in the U. S. and friendly foreign countries will further augment the increasing copper supply. All told, it is estimated that by 1955, not less than 450,000 tons of copper could be produced annually – over and above present production levels.

Accordingly, in 1955-56, domestic production plus imports could bring the U. S. copper supply to 1,800,000 tons yearly. This would represent an increase of about 20% over present levels. Based on historical comparisons, and barring a large-scale shooting war, this amount of copper could support a Federal Reserve Board Index of Industrial Production of 270, an increase of 24% over the present, and 45% above the first half of 1950.

• • •

These are the 'things to come' in copper. On the basis of the facts there is no necessity for considering long-range substitution of other materials for the red metal.

52320A

ANACONDA
COPPER MINING COMPANY

The American Brass Company
Anaconda Wire & Cable Company
International Smelting and Refining Company
Andes Copper Mining Company
Chile Copper Company
Greene Cananea Copper Company

PRODUCERS OF: Copper, Zinc, Lead, Silver, Gold, Cadmium, Vanadium, Superphosphate, Manganese Ore, Ferromanganese.
MANUFACTURERS OF: Electrical Wires and Cables, Copper, Brass, Bronze and other Copper Alloys in such forms as Sheet, Plate, Tube, Pipe, Rod, Wire, Forgings, Stampings, Extrusions, Flexible Metal Hose and Tubing.

3 reports

On the new Steam Homo method for bluing

1 Solves cadmium shortage

The cadmium shortage caught a New England plant with its inventory down. At the suggestion of an L&N field engineer, they used a Steam Homo already in their heat-treat to blue some sample parts. Now, 80% of the parts that were previously cadmium plated on one of their products are blued. When cadmium is again available, they intend to stick with Steam Homo bluing. Close fitting parts operate smoother . . . costs are lower . . . and, they never have to worry about a steam shortage. Another Steam Homo is on order.

2 Eliminates hazards

A large manufacturer of tools didn't like the smell and hazards of the bluing method being used on die stocks and tap wrenches. After a demonstration, the firm switched to the Steam Homo Method. Now, operating people are happy . . . working conditions greatly improved. So many other uses for this versatile furnace have been found that now there are seven Steam Homos . . . with four more on order.

3 Better corrosion resistance

A large midwestern manufacturer tested several methods of bluing stators and rotors of electric motors. Parts were blued, and then placed in a humidity cabinet at 100% humidity and 110 F until red rust appeared. Steam Homo blued parts were still in good shape after three months. The other parts had rusted in less than half this time. Now that the Steam Homo Method is an integral part of their production set-up, their inspectors claim that color uniformity and general appearance are the best they've ever seen.

THESE are typical examples of the results plants all over the country are getting with the new Steam Homo Method for bluing. Durable, uniform, corrosion resistant and eye appealing, this type of finish can be applied to any iron or steel product.

Because steam is used as the furnace atmosphere, the process is clean, non-hazardous and inexpensive . . . the Steam Homo can be installed directly in production lines.

To find out what the Steam Homo Method can do for your product, get in touch with the nearest L&N office or write to 4927 Stenton Ave., Philadelphia 44, Pa.

LEEDS NORTHRUP

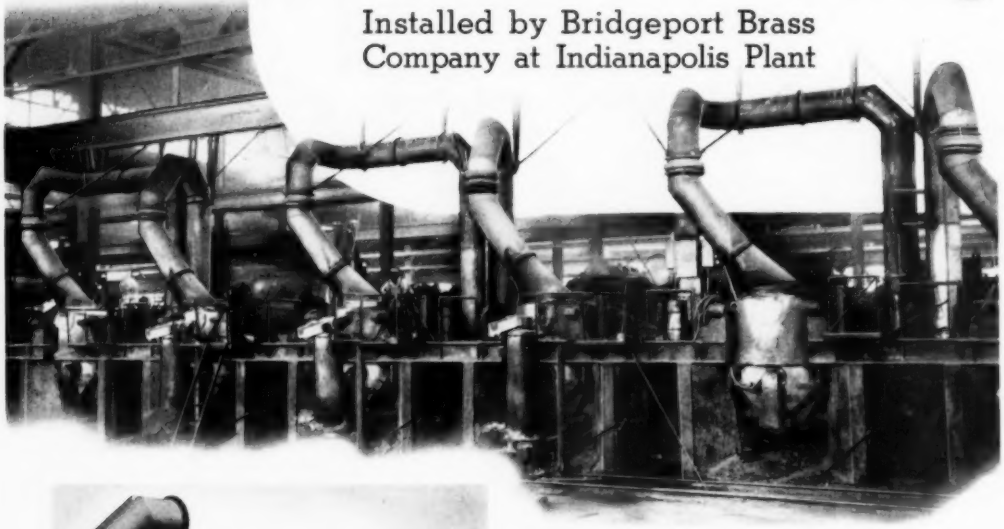
Jel Ad T-6201347

Metal Progress is published and copyrighted, 1952, by American Society for Metals, 7301 Euclid Avenue, Cleveland, Ohio. Issued monthly; subscriptions $7.50 a year. Entered as second-class matter Feb. 7, 1921, at the post office at Cleveland, Ohio, under the act of March 3, 1879.

PSC

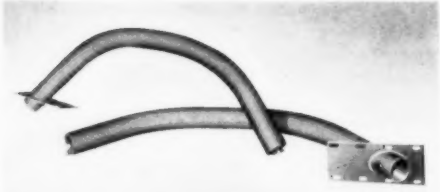
Thin-Wall Furnace Tubing

Installed by Bridgeport Brass Company at Indianapolis Plant



For External or Internal Furnace Applications, in Most Complicated Designs

These vent stacks loom up large in the casting shop of this "Bridgeport Brass" plant. But how to exhaust the fumes above the six Ajax electric furnaces during pouring of molten brass had loomed up equally large, as a problem. Pressed Steel Company's wealth of experience in fabricating complicated alloy tubing assemblies in any diameter up to 60" helped solve it. Each assembly, made of No. 10 gauge Type 430 alloy, is 73 feet long and ranges in diameter from 19" to 33". Featuring thin-wall return bends, PSC welded alloy tubing assemblies offer a lightweight method of construction that is introducing large savings in many types of installations requiring corrosion and heat resistance. See how The Pressed Steel Company can help you.

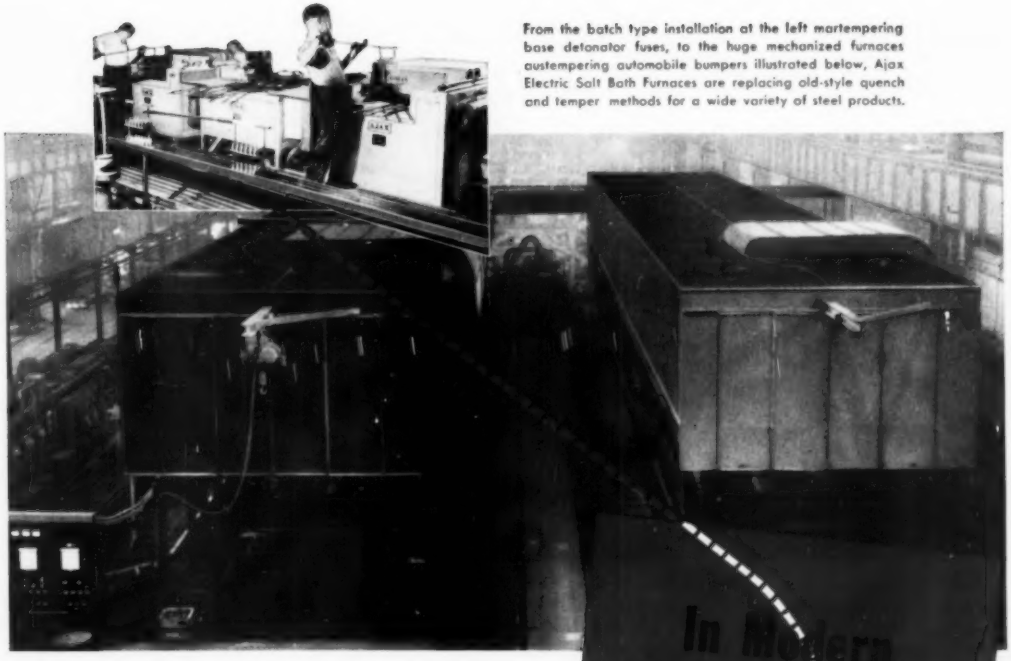


We precision assemble the most complicated designs of radiant furnace tubes. Send blue prints or write us to your needs.

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆



From the batch type installation at the left martempering base detonator fuses, to the huge mechanized furnaces austempering automobile bumpers illustrated below, Ajax Electric Salt Bath Furnaces are replacing old-style quench and temper methods for a wide variety of steel products.

From ring gears to plow points . . .

From bearing races to cast iron cylinder sleeves . . .

From uniformly shaped metal parts to odd and irregular sizes . . .

Scores of installations have proved the tremendous possibilities for economy, greater speed and efficiency in martempering and austempering, because all water and oil quenches are eliminated.

Distortion is so negligible that parts can be machine finished *before* hardening. Final grinding is eliminated or materially reduced. Scale, decarb and quench cracks are eliminated. Toughness and ductility are increased. The work is done materially faster—in less floor space—with lower labor costs. Let the Ajax Metallurgical Service Laboratory prove these claims on a specimen batch of your actual parts, under actual working conditions.

Write for Ajax Bulletin 120

AJAX ELECTRIC COMPANY, INC.
910 Frankford Avenue
Philadelphia 23, Penna.
World's largest manufacturer of electric heat treating furnaces exclusively

In Modern Heat Treating—the Trend is to MARTEMPERING and AUSTEMPERING

AJAX ELECTRIC SALT BATH FURNACES

HOLDING A CLOUD-BUSTER'S BREATH

Low pressure breathing oxygen cylinders must be perfect . . . there are no re-fills at 40,000 feet.

Many things can happen at 40,000-plus. But today's precision-trained sound-busters can usually handle them all. But let their vital oxygen supply go wrong and in a matter of seconds there is nothing that can be done.

To meet rigid service specifications, D. K. Manufacturing used Thor-Tung electrodes and Heliwelding. Using both the manual, water-cooled Heliweld holder for welding spuds into position, and the Heliweld Automatic Head for production line runs while welding cylinder halves, D. K. turns out breathing oxygen cylinders which test a leak-free 700 psi – hundreds of pounds above working pressure requirements.

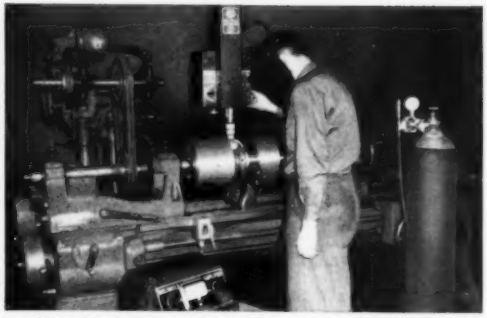
Inert gas-shielded Heliwelding eliminates the need for flux . . . prevents slag formation–permitting 'clear view' operation. Its gas-shielded electrode provides a highly concentrated arc . . . permitting exceptional welding speeds with a minimum of distortion.

Production-running these oxygen lifesavers is just one of the countless jobs Heliwelding can do in your plant or shop. Find out how it can be used for you. Write . . . or phone your nearest Airco Office. Ask for your copy of ADC-709: "Heliwelding–Catalog 9".

AT THE FRONTIERS OF PROGRESS YOU'LL FIND

AN AIR REDUCTION PRODUCT

Completed Breathing oxygen cylinders.



Manufactured by the D. K. Manufacturing Company, Chicago, Illinois, breathing oxygen cylinders like those above must be the products of perfect welding. To insure perfection on a production-run basis D. K. uses Heliwelding for their construction.

Companion-piece of the Heliweld Automatic Head, this jig-mounted manual, water-cooled Heliweld Holder fastens outlet spuds at the rate of nearly two hundred a day to begin the production run of oxygen breathing cylinders for D. K. Manufacturing Co.

AIRCO

DEALERS AND OFFICES IN PRINCIPAL CITIES

AIR REDUCTION

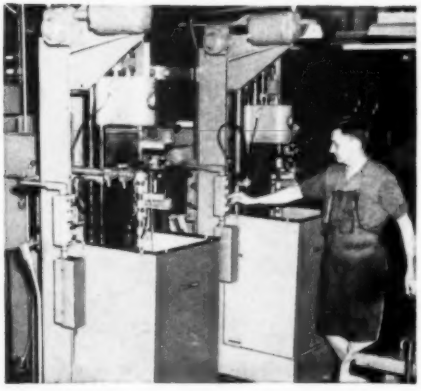
AIR REDUCTION SALES COMPANY • AIR REDUCTION MAGNOLIA COMPANY • AIR REDUCTION PACIFIC COMPANY

REPRESENTED INTERNATIONALLY BY AIRCO COMPANY INTERNATIONAL

DIVISIONS OF AIR REDUCTION COMPANY, INCORPORATED

WHICH OF THESE HEAT-TREATING PROBLEMS IS YOURS?

Westinghouse **RF** heating helped Saco-Lowell solve all six



Saco-Lowell Shops, makers of outstanding textile machinery, had always experienced problems with hardened bottom front rolls.

A Westinghouse 50 KW-450 KC RF Generator, with two standard vertical scanners, helped increase line production rates by 145% with total annual savings of $18,300.00. Direct labor costs have been cut 63%. Journal bearings are now ground after hardening, producing a higher quality roll. Formerly, every shaft required straightening; now this operation has been simplified and costs are reduced 70%.

Look at the results obtained by Saco-Lowell with a Westinghouse process that can handle 432 different rolls. Examine your heat treating problems. They, too, may be reduced, clarified, or eliminated entirely.

J-02243

Westinghouse Electric Corporation
Department P-43
2519 Wilkens Avenue • Baltimore 3, Maryland

Send me your informative case history booklet on induction heating.

Name .....

Company .....

Street .....

City ..... Zone ..... State .....

INDUCTION HEATING

LAVIN
Producing for Defense
The Lavin Organization is again being called upon to supply the foundry industry with many vital nonferrous alloys. We are confident that the combined efforts of our research, engineering, production and service departments, will enable us to meet the double challenge of producing for civilian life and Producing for Defense.
FREE . . . Write for your copy of the 12-Page Lavingot Technical Journal — Vol. 7, No. 4 — containing technical data, charts, specifications and identifications of Brass, Bronze, Aluminum and special nonferrous alloys.
R. LAVIN & SONS, INC.
• Refiners of Brass, Bronze and Aluminum
• Producers of Zinc Base Die Casting Alloys
Brass · Aluminum · Bronze · Zinc Base Die Casting Alloys
1900 R. LAVIN & SONS INC. 52 Years SERVING THE FOUNDRY INDUSTRY 1952
3426 SOUTH KEDZIE AVENUE · CHICAGO 23, ILLINOIS
REPRESENTATIVES IN PRINCIPAL CITIES

Airplane Production Schedules are easier to meet with—

DESPATCH

Engineered Equipment

INTERIOR UNIFORMITY
within plus or minus 5° F.

SPEED OF QUENCH
less than 10 seconds

This DESPATCH FURNACE is meeting rigid Government Aircraft specifications on SOLUTION HEAT TREATING of ALUMINUM

Leading aircraft manufacturers and sub-contractors of aircraft parts are depending upon DESPATCH engineered and installed heat treating furnaces, batch type aging ovens and other metal processing equipment to meet rigid government requirements. For example, this DESPATCH bottom entry, quick quench aluminum heat treating furnace is one of many now setting new production records in our speeded up defense program.

Designed by DESPATCH engineers to meet air-force specifications on the solution heat treating of sheet aluminum and aluminum castings, this modern high production furnace provides a rapid quench of less than 10 seconds and an interior heat uniformity of plus or minus 5°F. It is electrically heated and designed to operate at 1000° maximum. (Larger models furnished for electricity or indirect gas firing. Also, models available to operate at 1250° maximum.)

The furnace is of bottom entry design with quench pit below floor level. Racks are loaded and unloaded at floor level for speed and easier material handling. Elevator stops automatically at the 3 levels during the processing cycle and movements are controlled from a push button station.

DESPATCH CAN HELP YOU

Don't let defense contracts pass you by because of inadequate heat processing equipment. Despatch engineers are always ready to help you with your heat treating problems. They will offer advice, or will design, build and install equipment in your plant that will provide speed, plus uniformity and economy in all your heat processing operations.

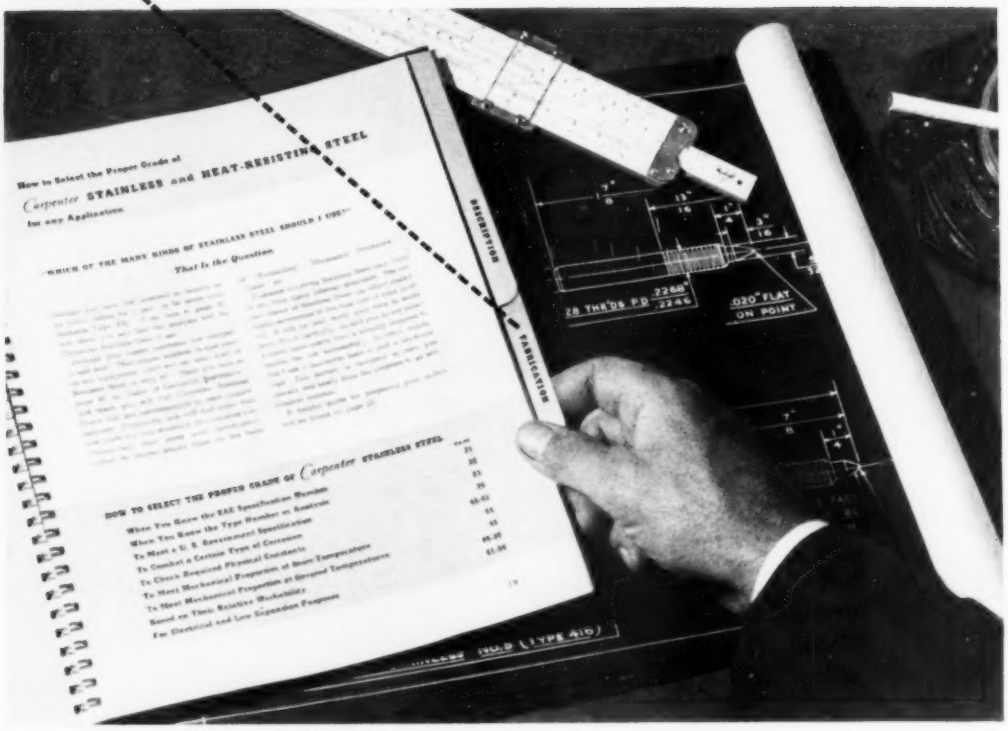
WRITE FOR FULL INFORMATION TO DEPT. P

FIFTIETH ANNIVERSARY
DESPATCH
OVEN COMPANY

MINNEAPOLIS OFFICE:
619 S. E. 8th Street

CHICAGO OFFICE:
4554 Broadway

X MARKS THE SPOT


How to Select the Proper Grade of
Carpenter STAINLESS and HEAT-RESISTING STEEL
for any Application
"WHICH OF THE MANY KINDS OF STAINLESS STEEL SHOULD I USE?"
That Is the Question
DESCRIPTION
FABRICATION
HOW TO SELECT THE PROPER GRADE OF Carpenter STAINLESS STEEL
28 THDS P.D. .2268" .2246"
.020" FLAT ON POINT

Where You'll Find Answers to Your Questions about Stainless

We've taken our own experience in making Stainless—added a lot that we've learned about fabricating Stainless—and put it in this 135-page Working Data Book.

To put this book of combined experience to work for you, to get a greater number of perfect parts from every pound of Stainless you buy, call your Carpenter representative and ask for a copy of the Stainless Working Data Book. If you don't already have a copy, he'll be glad to give you one. And when you talk to him, put him to work on any special problems you may have. He knows a lot about Stainless. And he is backed up by mill men who have spent their lives digging for ways to do Stainless jobs better.

Make full use of Carpenter's service to users of Stainless. Call your nearest Carpenter office today for a copy of "Working Data for Carpenter Stainless and Heat Resisting Steels" . . . or for personal attention to a specific problem.

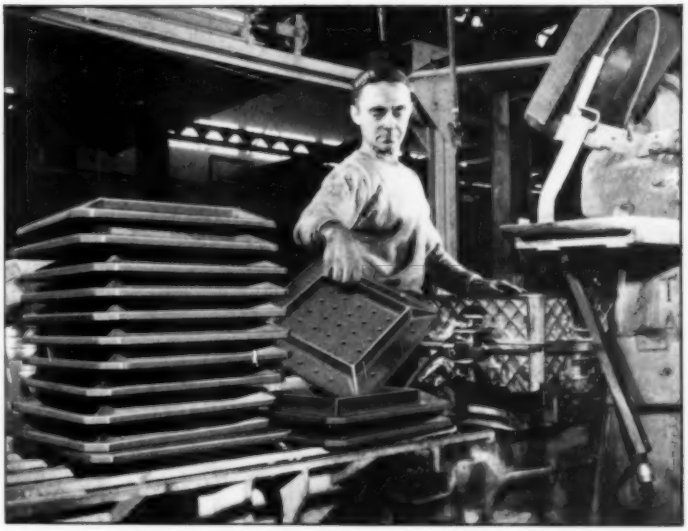
The Carpenter Steel Company, 133 W. Bern St., Reading, Pa.
Export Department: Carpenter Steel Co., Reading, Pa.—"CARSTEELCO"

Carpenter
STAINLESS STEEL
takes the problems out of production

For help with Stainless problems Call Carpenter. Warehouses in principal cities throughout the country.

"Burning and Breakage loss not a factor since using EDCO Dowmetal BOTTOM BOARDS"

...says Olney Foundry, LINK-BELT COMPANY, Philadelphia, Pa.



Modern mechanized foundries, like Olney Foundry, rely on the durability of EDCO DOWMETAL Bottom Boards. Even after 3 years of constant use, the EDCO DOWMETAL Bottom Boards at Olney Foundry continue to give maximum production efficiency. That's why Olney Foundry says with confidence: "Burning and breakage loss not a factor since using EDCO DOWMETAL Bottom Boards".

EDCO DOWMETAL Bottom Boards also help produce castings that are true to pattern. The exclusive grooved and vented design permits escape of gasses, and insures mold stability. Causes for rejects are kept to a minimum.

"EDCO DOWMETAL Bottom Boards are now permanent equipment in our foundry", adds Olney Foundry. "They help increase output while cutting production costs, and have more than paid for themselves in savings alone effected by substantially reduced replacement costs."

Regardless of the size of your foundry operation, your molders will like handling these boards because they are strong—yet light in weight, easy to stack, and do not splinter. EDCO DOWMETAL Bottom Boards will not warp or rot—there are no nails to come out, nothing to break or split—no upkeep.

Write us, or phone CApitol 7-2060 for price schedule and list of 74 standard sizes available from stock.

Olney Foundry was established in 1920 as a division of Link-Belt Company in Philadelphia, Pa. Olney Foundry produces gray iron castings of every description ranging in size from a few ounces to ten tons in weight. EDCO DOWMETAL Bottom Boards have been extremely helpful in maintaining the high degree of modern mechanization characteristic of Olney Foundry.

The illustrations at right show some of the foundry production equipment used by Olney Foundry to achieve their high degree of modern mechanization. The pallet-type gravity conveyor in the top panel shows molds on EDCO DOWMETAL Bottom Boards being moved to the pouring area. This pouring area is shown in the lower panel. The molds are automatically dumped after pouring and the EDCO DOWMETAL Bottom Boards are returned by the conveyor to the molder.

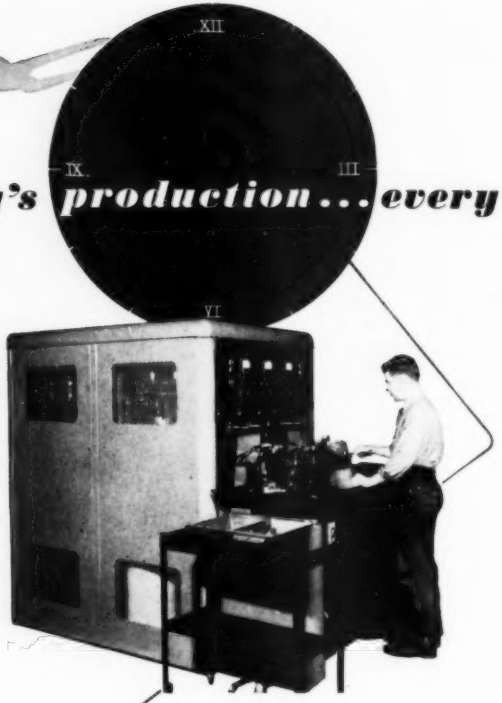
EDCO CHRISTIANSEN CORPORATION

CHRISTIANSEN CORPORATION

1519 N. KILPATRICK AVE. • CHICAGO 51, ILLINOIS

ALUMINUM ALLOY INGOTS • ZINC BASE DIE CASTING ALLOYS

a full day's production . . . every day!



Mr. H. H. Manning, vice president of Champion DeArment says, "What we like about the Lindberg Induction Heating Unit is its accessability for inspection and preventative maintenance. It has been used 8 hours per day since its installation and we have had practically no interruption of production."

Champion DeArment Tool Company, Meadville, Pa., use the Lindberg 2-station Induction Heating Unit to harden their famous CHANNELLOCK pliers. Their unit, like all other Lindberg Induction Heating Units, is designed to give a full day's production every day . . . without costly, irritating breakdowns that skyrocket production costs ☆ ☆ **OVERSIZED COMPONENTS**—oversized components, built into every Lindberg Unit, insures uninterrupted production and hundreds of "bonus hours" of service life ☆ ☆ **SAFETY OVERLOADS**—safety overloads, designed for *any eventuality* protect valuable equipment, reduce rejects and guard against human error ☆ ☆ **"CHECKLITE" TROUBLE SHOOTING**—a built-in "CHECKLITE" system maintains a constant vigil, and when safety overloads operate a signal light indicates the location of the overloads for immediate correction ☆ ☆ For full details on 5, 10, or 25KW Units, write for Bulletin 1440 Lindberg Engineering Company, 2448 West Hubbard Street, Chicago 12, Illinois.

LINDBERG

HIGH FREQUENCY DIVISION

tool steel has our attention!

Tool steel holds *our* interest. We have always been interested in tool steel. That is why we are the number one producer.

Our interest in tool steel continues in these ways: Our research and development is kept right in step with the latest trends in the industry. Our competent metallurgical staff is available to assist you in any problems you may have. And our conveniently-located warehouses maintain ample stocks so they can supply your needs promptly.

SEND TODAY for the unique Crucible Tool Steel Selector —a twist of the dial gives the tool steel for your application.

Rex® High Speed Steels
Peerless Hot Work Steels
Halcomb 218
Chro-Mow®
Sanderson Carbon Tool Steels
Ketos®
Airkool Die Steel
Airdi® 150
Nu-Die V Die Casting Steel
CSM 2 Mold Steel
La Belle® Silicon #2
Atha Pneu

SPECIFY YOUR TOOL STEELS BY THESE BRAND NAMES

Crucible Steel Company of America
Dept. MP, Chrysler Building, New York 17, N. Y.

Name_____

Company_____ Title_____

Address_____ City_____ State_____

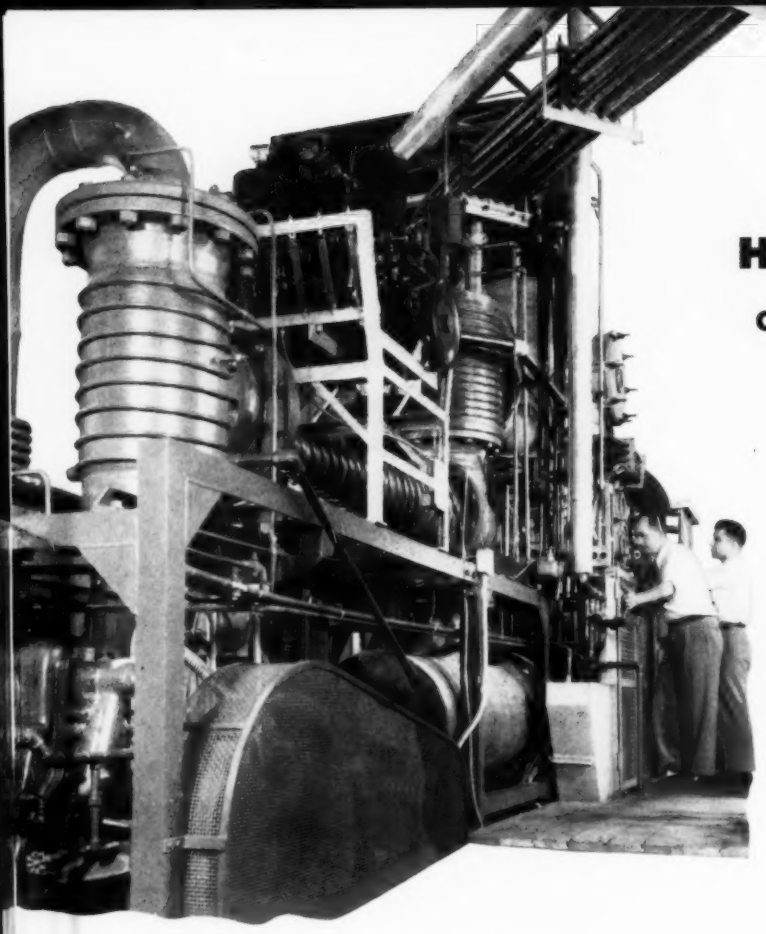
9" diameter, 3-colors

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

TOOL STEELS

CRUCIBLE STEEL COMPANY OF AMERICA · TOOL STEEL SALES · SYRACUSE, N. Y.



High vacuum develops muscles for "moly"

Pure molybdenum is sensitive to oxygen at the temperature it takes to melt it . . . and "moly" with oxygen is not much use. Jet engines, rockets, and other equipment need the pure metal because it stands up under heat that melts the strongest steels, but if there's oxygen in it the advantage vanishes.

High vacuum solves the problem. Climax Molybdenum Company of Detroit, Michigan, hydraulically compresses pure molybdenum powder and sometimes molybdenum chips with a little carbon. This mass is sintered into a crude stick which serves as a consumable electrode in an arc. The molten metal is caught in a pool which serves as the other electrode while it builds up into a half-ton ingot of malleable, ductile molybdenum.

The molybdenum turns out malleable and ductile because *high vacuum* gets rid of the injurious oxygen.

Why, you may ask, don't they just use an inert gas? Bear in mind that at the high vacuum under which these operations are carried out (20 microns Hg) oxygen content is equivalent to about 0.0026% at atmospheric pressure. Inert gas pure enough and in sufficient quantity to dilute atmospheric oxygen to this level would be staggering in cost. A DPi oil ejector pump, uniquely economical to operate, creates the vacuum in the sizable space needed for the whole series of continuous operations and gets rid of the gases evolved.

In supplying equipment for high vacuum metallurgy, DPi pools its own diversified experience in high vacuum technology with the experience of leading manufacturers of metallurgical furnaces.

In many other fields, too, where high vacuum processing has earned a useful role, DPi stands ready to help you with the vital details that add up to efficient, profitable production. Write to ***Distillation Products Industries,*** Vacuum Equipment Department, 753 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).

DPi

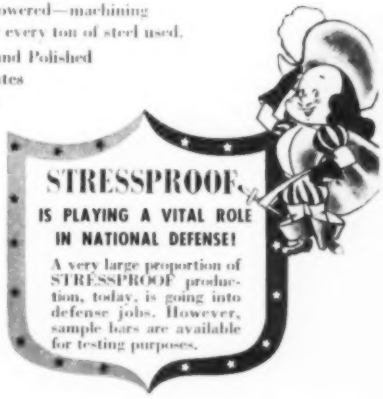
high vacuum research and engineering

Also . . . vitamins A and E . . . distilled monoglycerides . . . more than 3500 Eastman Organic Chemicals for science and industry

GROUND and POLISHED STRESSPROOF®

The cable drum shaft of this Army truck winch was formerly made from 1140 alloy steel—cold-drawn, heat-treated, stress-relieved, ground, and polished. It was difficult to machine, and expensive. Several years ago this alloy bar was replaced with Ground and Polished STRESSPROOF at a considerable saving. Steel costs were *substantially* lowered—machining time was reduced. As a result, the over-all savings amounted to $50.00 for every ton of steel used.

This is typical of the sensational savings made possible with Ground and Polished STRESSPROOF—the finest ground bar steel produced. This bar eliminates many costly manufacturing operations because of its unique combination of five important qualities in the bar: High Strength . . . Excellent Wearability . . . Minimum Warpage . . . Accurate, Polished Surface . . . and Machinability fully 50% faster than heat-treated alloys of the same hardness!


STRESSPROOF
IS PLAYING A VITAL ROLE IN NATIONAL DEFENSE!
A very large proportion of STRESSPROOF production, today, is going into defense jobs. However, sample bars are available for testing purposes.

La Salle STEEL CO.

1424 150th STREET, HAMMOND, INDIANA

Manufacturers of the Most Complete Line of Cold-Finished and Ground and Polished Bars in America

PRECISE LOAD INDICATION

For All Your Tests With

5 SCALE RANGES

Only Riehle Universal Testing Machines give you 5 SCALE RANGES — the equivalent of 5 separate testing machines in one. 5 scale ranges provide complete coverage of the machine's full capacity and permit you to select the one range most applicable for any given test. Each range is covered by a single revolution of the dial pointer.

Tension test on Riehle 120,000 lbs. Hydraulic Universal. Photo courtesy Cleveland Tank Plant, Cadillac Motors Corp.

RIEHLE HYDRAULIC UNIVERSAL TESTING MACHINES

Model	Range 1 From 0 to	Range 2 From 0 to	Range 3 From 0 to	Range 4 From 0 to	Range 5 From 0 to
PH-10	10,000	5,000	2,500	1,000	500
PH-20	20,000	10,000	5,000	2,000	1,000
PH-30	30,000	15,000	6,000	3,000	1,500
PH-60	60,000	30,000	12,000	6,000	3,000
PH-120	120,000	60,000	30,000	12,000	6,000
PH-200	200,000	100,000	50,000	20,000	10,000
PH-300	300,000	150,000	60,000	30,000	15,000
PH-400	400,000	200,000	80,000	40,000	20,000

CONSTANT ACCURACY — Riehle Universals are guaranteed to be within one half the normal tolerance allowed by ASTM and Federal specifications.

SINGLE DIAL CONTROL — One dial controls speeds for the complete testing cycle, from fast forward to fast return.

LOW TABLE AND GRIPPING HEAD — Provide easy access to testing tools and specimens.

EASY TO INSTALL — Riehle Universals are floor level units, requiring no installation pits.

NEW! 32-PAGE CATALOG

A complete book on all Riehle Hydraulic Universal Testing Machines, including illustrations, specifications, advantages, operating details. Send for your copy today!

RIEHLE TESTING MACHINES

Division of

AMERICAN MACHINE AND METALS, INC.

East Moline, Illinois

Representatives in Principal Cities

FOREIGN SALES OFFICE: Woolworth Building, New York 7, N. Y.

DONE TEST IS WORTH A THOUSAND EXPERT OPINIONS

Riehle Testing Machines Division
AMERICAN MACHINE AND METALS, INC.
Dept. MP-352, East Moline, Illinois

Without obligation, please send new catalog on Riehle Hydraulic Universal Testing Machines.

Firm Name _____

Address _____

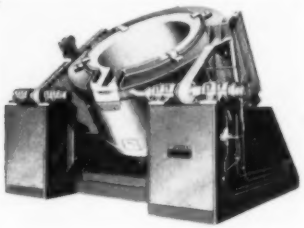
City _____ Zone _____ State _____

Name and Title _____

Engineering Digest

OF NEW PRODUCTS

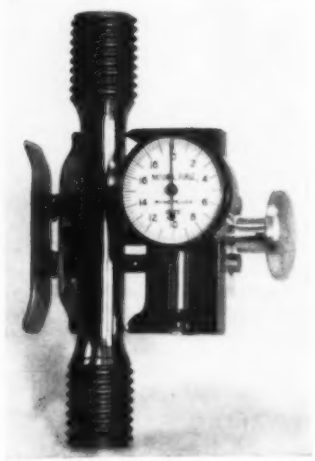
MELTING FURNACE: A 25,000-lb. hydraulic tilting-type melting pot furnace has been designed and manufactured by Bellevue Industrial Furnace Co. The first installation is for Kirksite metal. Furnace and pot are tilted by means of hydraulic cylinders which are completely piped with flow control valves installed in



oil lines, allowing adjustment of flow control to give desired tilting speed. Metal is heated by means of burners mounted below the pot, firing tangentially to give a uniform heat distribution and to avoid flame impingement on the pot. The unit may be built for gas, oil, or gas-oil combination firing.

For further information circle No. 390 on literature request card on p. 32B

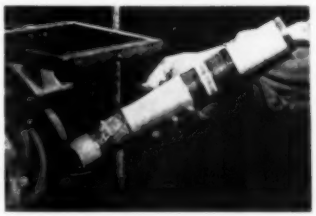
EXTENSOMETER: A newly designed, simplified extensometer indicates the elongation of metallic and plastic specimens in tension testing directly, without a multiplying lever.



The extensometer, which weighs only 7 oz., attaches to the specimen by spring clamps which are opened or closed while it is held in the palm of the hand. It readily adjusts to take wire, sheet, plate or round specimens up to a maximum thickness or width of ½ in. Standard gage length is 2 in. Special gage length is 1.4 in. It registers elongation to 0.045 in. in dial gradients of 0.0002 in. The larger-sized dial on the jeweled indicator permits accurate readings to 0.0001 in. The manufacturer is National Forge and Ordnance Co., Testing Machine Div.

For further information circle No. 391 on literature request card on p. 32B

WAX LUBRICANT: A blend of solid waxes put up in stick form in order to facilitate use in certain types of metalworking operations is now being marketed by Johnson's Wax. This product is said to provide a durable, clean lubrication for metal sanding,



metal sawing, pipe cutting and threading, drilling, tapping, grinding and flush riveting. Wax lubrication also provides a better finish on the worked pieces, tests showed. Stik-Wax can be applied manually, as needed, by the operator or set in a position so that it is automatically applied as the machine operates.

For further information circle No. 392 on literature request card on p. 32B

BRIGHT SILVER PLATING: Hanson-VanWinkle-Munning Co. has announced a new commercial silver plating process which makes it possible to obtain bright silver plate without buffing or scratch brushing. Called Silver-Lume, the new process produces a noticeably more tarnish-resistant surface, has wide bright range, requires no special equipment, produces an excellent deposit-distribution and uniform color and is easily controlled. Conventional plating equipment as used for ordinary cyanide silver baths is satisfactory. A new bath is prepared from silver cyanide and potassium carbonate with small amounts of Silver-Lume brighteners A and B. Existing solutions can, in most cases, be converted to the Silver-Lume process.

For further information circle No. 393 on literature request card on p. 32B

SUBZERO CHEST: Revco, Inc., has announced their new subzero chest, equipped with "Sub-lid" to minimize heat loss during usage. Temperature control is adjustable for any controlled temperature to as low as 90° below zero in the 1.5-cu.ft. model in

normal room temperature. Temperatures may be controlled to as low as 80° below zero in the 6.5-cu.ft. model. Temperature of minus 95° and 85° F., respectively, may be obtained in these models by continuous running.

For further information circle No. 394 on literature request card on p. 32B

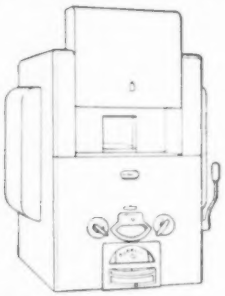
SAW BAND: A saw band specifically designed for high-speed friction sawing has been introduced recently by The DoAll Co. Through the use of a heat treating process the saw band teeth are permanently anchored and locked in place. The technique of friction sawing entails saw velocities up to 15,000 ft. per min. At such speeds the material being cut is brought to the softening point through friction created between the cutting edge of the blade and the work. As the material is fed into the saw it becomes soft and is removed from the kerf by the teeth of the high velocity blade. Stainless steel of ⅛ in. thickness may be cut at the high rate of 1200 linear in. per min. Typical ap-

FOR SCIENTISTS EVERYWHERE

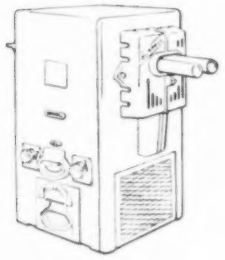
ELECTRIC FURNACES

by BURRELL

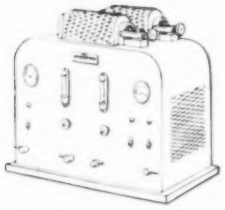
To you—the chemists, metallurgists and laboratory technicians with whom we have been privileged to work through the years—belongs the credit for Burrell's leadership as a supplier of electric furnaces for analysis, control and production. You told us your needs; we developed apparatus to meet those needs. As a result of this cooperation, many improvements have been made for easier operation, greater safety and dependable operation. Today, Burrell offers as comprehensive a line of high and low temperature furnaces as can be found in any one source.



BURRELL UNIT-PACKAGE BOX AND MUFFLE FURNACES are designed for either low or high temperature operation. In a range from 600° F. to 2000° F., you can perform efficiently such functions as ashing, drawing, igniting, tempering. Above 2000° F. and on into the high white, these versatile units are equally adaptable for such services as sintering, melting, clinkering, fusing and high speed hardening. All are ruggedly built and easily operated. Temperature control is automatic. Burrell Bulletin No. 315 provides all needed data about five different models.



BURRELL UNIT PACKAGE TUBE FURNACES are for determining carbon or sulfur in ferrous analysis and any other similar procedures which require continuous operating temperatures up to 2650° F. Various models are offered to answer individual requirements for limited use, average use or high speed production. All are self-contained and fully equipped furnace units, ready for connection to your power supply. They are easy to install and simple to operate and will reward users with long, trouble-free service. Ask for Burrell Bulletin No. 310.



BURRELL COMBUSTRON is a new high frequency induction heater for rapid determination of carbon-by-combustion analysis in steel. Accuracy with coarse, fine or pin-type samples has been proved by extensive tests. The Combustron is always ready for continuous or intermittent use. It is a self-contained, fully equipped instrument ready to plug into the power supply and put to immediate use. No pre-heat time is needed; you insert the sample and snap the switch. A one tube model is offered for average use, a two-tube model for heavier production. Write for Burrell Bulletin No. 319.

BURRELL CORPORATION

2223 FIFTH AVENUE, PITTSBURGH 19, PENNSYLVANIA

MANUFACTURERS AND DISTRIBUTORS OF SCIENTIFIC APPARATUS AND LABORATORY CHEMICALS

plications are castings, sheet metal fabrication, tubing, armor plate, high speed cut-off work, and general shaping of ferrous materials with work thickness ranging up to 1 in.
For further information circle No. 395 on literature request card on p. 32B

OVEN: A new mechanical convection oven is being introduced by Blue M Electric Co. Called the "Con-Wate" (constant weight of air circulation at all temperatures), heat uniformity

throughout the heated chamber is obtained by control of velocity between 50 and 250 ft. per min. Blower is direct drive; temperature range, to 550° F.
For further information circle No. 396 on literature request card on p. 32B

COMPRESSION TESTING: Accurate compression and crushing tests can be made quickly and easily with a low-cost, portable machine by Labquip Corp. The load is applied through a hydraulic system actuated by compressed air and is indicated on the dial of a double proving ring, which is used to obtain greater accuracy in

the low range in tests which involve large loads and to eliminate the necessity of changing rings for different tests. When the capacity of the more sensitive outer ring is reached, the heavier inside ring is brought into action. The low range of the double proving ring is sensitive to loads of 0.1 lb.

An important feature is the ability to release the load instantaneously at any time during the test or at the point of failure and thus to keep the specimen intact for any measurements, photographs or similar requirements. The standard model has a capacity of 350 lb. under an operating air pressure of 100 psi., but machines with capacities up to 1000 lb. can be supplied.
For further information circle No. 397 on literature request card on p. 32B

MARFORM DEEP DRAWING: The Marform Div. of the Loewy Construction Co. has developed a simplified pressure control mechanism for use with Marform equipment. This mechanism consists of a flexible strip cam which is readily adjustable merely by turning the friction-locking adjustment knobs. The developed profile on the strip cam determines the magnitude of the rubber pad forming pressure as utilized by the Marform

process. In addition to the pressure control, the setting of the three sliding indicators determines the upper and lower limits of the draw depth, as well as the point at which intense forming pressure is built up for setting radii or shearing. These controls are adjustable in a matter of minutes by setting the calibrated rods to predetermined positions. Once such controls are set, all that is required of the operator is to place a blank in the machine, push a single button, and then remove the drawn part which is automatically stripped from the punch.
For further information circle No. 398 on literature request card on p. 32B

SLAG-RESISTANT BRICK: A clay-graphite refractory brick for increasing the life of installations having slag erosion problems, has been announced by North American Refractories Co. It is a prefired product and has the ability of shedding slag, preventing rapid deterioration of the refractory. Successful installations include ladles, blast furnace splasher plates, blast furnace runners, pig machine runners, electric furnace runners, cupola spouts and forehearths.
For further information circle No. 399 on literature request card on p. 32B

WET BLASTING: Reducing glare on plated parts is a typical application for the Liquamatte, a new wet blasting machine recently introduced by American Wheelabrator & Equipment Corp. The dials in the picture have both been chromium plated, but the one on the right has been given a surface treatment by liquid abrasive

blasting, while the dial on the left has been untouched since plating. Since the abrasive action can be closely controlled through the use of very fine-mesh abrasives, there is no danger that recessed features or lettering on work will be damaged.
For further information circle No. 400 on literature request card on p. 32B

FLEXIBLE GRINDING WHEEL: Norton Co. has announced a new reinforced, flexible, hub-type grinding wheel known as the Norton BFR wheel. With this resinoid, fibre construction wheel, an operator can now rough grind, finish grind, and notch

—all with the same wheel. Designed for use on right-angle or sander-type portable grinders, the new wheel will generally be used to smooth down welds, blend surfaces on contours, and notch risers in all kinds of castings.
For further information circle No. 401 on literature request card on p. 32B

HIGH-SPEED CAMERA: A modification of the Kodak high-speed camera which permits both the mechanical and electrical aspects of a subject to be recorded simultaneously on the same film has been announced

Cut quenching costs, reduce rejects on steels of critical hardenability with GULF SUPER-QUENCH

Is the current alloy shortage creating a heat-treating problem for you? Must you accept alloy steels with less chromium, manganese, molybdenum, or vanadium than you originally specified? Then you'll be interested in the performance of Gulf Super-Quench. Because of its dual-quenching power, this outstanding oil helps offset the lower hardenability of today's substitute steels.

Gulf Super-Quench passes through the vapor stage far more quickly than conventional quenching oils. This means that the cooling rate is extremely fast at the outset, an important factor in the depth and uniformity of hardening. In the succeeding stages Gulf Super-Quench has a slow cooling rate, like that of conventional quenching oils, and therefore has the same minimum tendency toward distortion and cracking of the metal parts.

Greater quenching power of Gulf Super-Quench adds up to greater depth of hardening and more uniform hardness! This means fewer rejects and lower quenching costs. One of the most practical advantages of Gulf Super-Quench is greater uniformity of results on steels of variable hardenability.

For further information on Gulf Super-Quench, call in a Gulf Sales Engineer today.

Gulf Oil Corporation · Gulf Refining Company
Gulf Building, Pittsburgh 30, Pennsylvania

GULF SERVES INDUSTRY

by the Eastman Kodak Co. The modification consists of the addition of a second lens to the camera to record the images on the tube of a cathode-ray oscillograph through the back of the film, while the mechanical aspects of the subject are being photographed on the front. This record will permit the photographer to present a complete picture of the behavior of electro-mechanical devices, and will also permit easy correlation with strain, acceleration, vibration and other signals fed to the oscillograph in many nonelectrical problems.

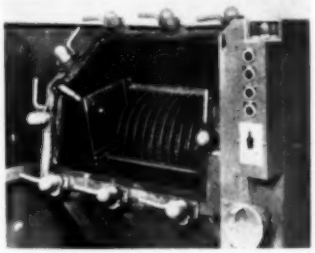
For further information circle No. 402 on literature request card on p. 32B

TENSILE TESTER ACCESSORIES: Several new accessories have been added to the Instron tensile tester. Outstanding among the features of this precision electronic testing instrument is its wide range, extending

from 2 g. to 5000 lb. In addition, a wide selection of jaw speeds is provided, ranging from 0.02 to 20 in. per min. The electronic load weighing system is based on the electric strain gage principle to detect variations of load in the specimen under test. Characteristic of this instrument is its high speed of response and virtually zero motion of the upper jaw. The motion of the lower jaw is controlled by a positional servo system assuring a constant rate of elongation in either direction and providing almost instant starting, stopping or reversing. The addition of compressional accessories has extended the versatility of the Instron tester. The same flexibility of control for operating the motion of the crosshead in tensile measurements is now possible for compression testing.

For further information circle No. 403 on literature request card on p. 32B

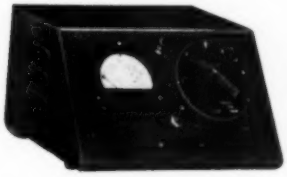
MECHANICAL FINISHING: A new addition to the Roto-Finish Co. line of tumbling machines is especially designed to effectively finish disk-type circular parts at a low cost. The machine, of the stationary fixture type, has a rubber-lined compartment with 18 cu.ft. capacity. Once the



machine is started, an automatic timer is available for controlling the operation from 0 to 20 hr. without attention by an operator. A variable speed power unit enables the operator to vary the speed of the cylinder from 10 to 30 rpm.

For further information circle No. 404 on literature request card on p. 32B

TEMPERATURE CONTROLLER: Recent improvements in design and in the electrical circuit of its line of temperature controllers are announced by Thermo Electric Mfg. Co. The instrument employs a sensitive thermostatic switch to operate a relay system which carries the load current of the connected equipment. By turning the switch control knob on the instrument panel the load current can be regulated anywhere between 5%



and 100% time "on". Any desired temperature within the capacity of the connected equipment can be selected and held. The instrument automatically compensates for changes in line voltage and will maintain constant watt-hour input and temperature regardless of wide variations in line voltage. The instruments are available either with or without indicating pyrometers and thermocouple, and for load ratings up to 4600 watts, 110 v. and 6000 watts, 220 v.

For further information circle No. 405 on literature request card on p. 32B

Wherever it's HOT specify Sicon

NEW IMPROVED SILICONE-BASE HEAT-RESISTANT FINISH

Protects Stewart Warner's New Saf-Aire Wall Furnace

Quality finish specifications for this heating unit called for a coating that would stand 500° and still retain its color and gloss—a temperature far above that incurred in normal operation. Ordinary heat resistant coatings failed. SICON *Ivory* and SICON *Beige* worked perfectly...just as SICON has solved so many other finish problems. *Write for dynamic proof of SICON'S amazing stability under heat! New Brochure now ready.*

Sicon

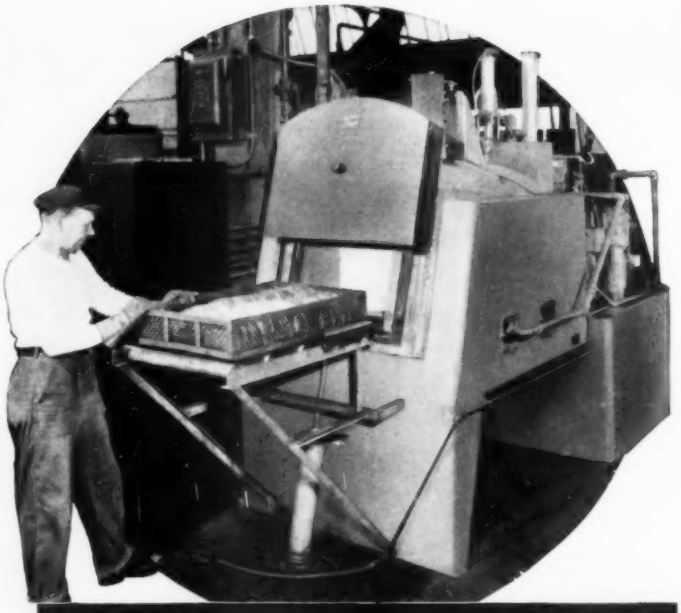
Silicone-Base Finish is manufactured exclusively by

MIDLAND INDUSTRIAL FINISHES CO.

Waukegan, Illinois

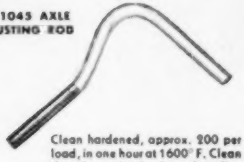
ENAMELS · SYNTHETICS LACQUERS · VARNISHES

DISTORTION REDUCED... PRODUCT QUALITY IMPROVED with a...



Ipsen T-250 Heat Treating Unit in large Farm Equipment plant. Operator simply loads the unit and sets the heat treating cycle. Work is handled through heat and quench (or cooling) cycle automatically. Change-over from one job to another is fast and simple.

SAE-1045 AXLE ADJUSTING ROD



Clean hardened, approx. 200 per load, in one hour at 1600° F. Clean threads maintained, rethreading operation eliminated. Wt. per piece — .37 lbs.

SAE-1095 TRIGGER SPRING

Clean hardened, 350 per load, in 30 minutes at 1500° F. Distortion reduced, cleaning operation eliminated. Wt. per piece — .19 lbs.

SAE-1045 HITCH HOOK

Clean hardened, 60 per load, in one hour at 1600° F. A scale-free and a more rust resistant finish is produced, cleaning operation eliminated. Wt. per piece — 4 lbs.

SOFT-CENTER STEEL JOINTER BLADE

Clean hardened, 69 per load, in one hour at 1625° F. Distortion reduced, cleaning and buffing eliminated. Wt. per piece — 3.1 lbs.

THE AUTOMATIC Ipsen HEAT TREATING UNIT

NEW IPSEN STANDARD AUTOMATIC HEAT TREATING UNIT

Described at left are typical results obtained by a Farm Machinery Manufacturer in clean hardening more than 50 different workpieces on a production basis in an Ipsen Automatic Heat Treating Unit. Controlled, automatic batch processing from heat through quench, combined with sealed atmosphere operations, have also effected important improvements in product quality. For example, highly uniform results are now obtained from load to load which permits more accurate control of wear. Also clean, scale-free, more rust-resistant work is obtained. Further, distortion is held to close limits, which not only speeds production but also simplifies assembly and field service problems.

Bright Carbonitriding Cuts Processing Time 75%

In addition, 15 different workpieces requiring case depths ranging from .015 - .035" are also automatically processed in the Ipsen. On these jobs, the Ipsen exclusive bright carbonitriding process is employed. This method cuts processing time as much as 75%, and improves delivery schedules. Workpiece distortion is also accurately controlled, and extra handling and cleaning operations are eliminated. In use for more than nine months, the unit has operated on a 24 hour schedule, with no downtime for maintenance.

Write **FOR MORE FACTS TODAY** — Get the complete story on modern Ipsen Heat Treating Units today. Three standard sizes are available — from 250 to 600 lb. capacities. Write for free data sheets describing and illustrating results and procedures on actual jobs.

IPSEN INDUSTRIES, INC., 723 South Main Street, Rockford, Illinois

Production units for CARBONITRIDING · CARBURIZING · HARDENING · BRAZING · MARTEMPERING

What's New

IN MANUFACTURERS' LITERATURE

406. Abraser

Bulletins illustrate and describe a durable precision instrument for evaluating the resistance of surfaces to rubbing abrasion. Also several specimen holders for use with abraser. *Taber Instrument Corp.*

407. Abrasive Belt

4-page, illustrated bulletin describes advantages of new "61" contact wheel. Time charts show how new, specially designed rubber wheel provides longer belt life and increased cutting rate. *Abrasives Div., Carborundum Co.*

408. Abrasive Belt Machines

30-page illustrated booklet of case histories. *The Porter-Cable Machine Co.*

409. Abrasive Cutting

Informative 36-page booklet, DH-301, gives basic principles of abrasive cutting, its methods and applications. *Campbell Machine Div.*

410. Alloy Brazing

Brazing News No. 54, "Low Temperature Brazing", covers silver alloy brazing with Easy-Flo and Silflos. Tells where and how to use these alloys to the best advantage. Shows many interesting applications; describes fast brazing techniques. *Handy & Harman.*

411. Alloy Steels

New 16-page, pocket-size booklet entitled "Republic Alloy Steels and How to Get the Most Out of Them" contains seven case histories selected from widely varied fields to demonstrate the versatility of alloy steels. *Republic Steel Corp.*

412. Alloy Steels

Data book on the selection of the proper alloy steel grades for each manufacturer's needs. *Wheelock, Lovejoy & Co.*

413. Alloys, Fabricated

Catalog available showing cost-cutting fabricated heat treating equipment for higher payloads and better quality. *Rolock, Inc.*

414. Alloys, Heat Resisting

"Thermalloy 30" gives property data for 21% Cr, 9% Ni heat-resistant alloy. *Electro-Alloys Div.*

415. Aluminum

"Alcoa Aluminum Impact Extrusions" gives information on impact extrusion process and service. Shows range of shapes for engineering. *Aluminum Co. of America.*

416. Aluminum Alloys

36-page book on analysis of aluminum, brass, bronze, alloy specifications. *Sonken-Galamba Corp.*

417. Aluminum Bronze

Bulletin PI-4 gives complete information on aluminum bronze as applied in corrosion-resistant service. Fully illustrated. *Ampco Metal, Inc.*

418. Aluminum Cans

New booklet presents improved packaging methods, showing how aluminum can replace the "tin" can. *Reynolds Metals Co.*

419. Aluminum Coiled Tubing

New booklet on a general-purpose aluminum coiled tube with numerous industrial uses now ready for distribution. *Aluminum Co. of America.*

420. Analysis

A 16-page booklet explains the theory behind colorimetry, fluorometry and nephelometry and the operation of a new instrument combining all of these techniques. *Fisher Scientific Co.*

421. Arc Furnaces

42-page illustrated brochure on application of electric arc furnace to smelting and refining of ferrous and nonferrous metals. *Pittsburgh Lectromelt Furnace Corp.*

422. Arc Welding

Heliwelding, Airco's inert, gas-shielded arc-welding process for all-position welding of aluminum, magnesium, stainless steel, brass and copper, is fully described in ADC-709, Catalog 9. *Air Reduction Sales Co.*

423. Barrel Finishing

Bulletin describes new chemical in paste form for descaling, roughing, deburring, cleaning, and finishing nonferrous parts by barrel tumbling. *Blue Magic Chemical Specialties Co.*

424. Belts, Wire

Attractive new catalog No. 51 fully illustrates and describes complete line of wire belts for industry. *Ashworth Brothers, Inc.*

425. Beryllium Copper

Helpful engineering information contained in new monthly series of beryllium copper technical bulletins. *Beryllium Corp.*

426. Blast Cleaning

Bulletin explains how airless abrasive blasting can be applied to solve the cleaning problems in industries concerned with ordnance material production. *American Wheelabrator & Equipment Corp.*

427. Blast Cleaning

Bulletin 32-B contains photographs and complete descriptions of AG blast cleaning cabinets for all types of industrial applications. *Rusmetin Mfg. Co.*

428. Blowers

Bulletin No. 300-S illustrates, diagrams and informs concerning a new constant pressure turbo blower and properly selected piping. *North American Manufacturing Co.*

429. Bottom Boards, Magnesium

Complete information and price schedule on magnesium bottom boards for maintaining high quality castings and mold stability. *Christiansen Corp.*

430. Box Muffle Furnaces

Bulletin No. 315 describes box and muffle furnaces designed for either low (ashing, drawing, igniting, tempering) or high temperature (sintering, melting, clinkering, fusing) operation. *Burrell Corp.*

431. Buffs

New brochure describes the various features and applications of pressure-cooled Airflow buffs and Aircon wheels. *United Buff Products Corp.*

432. Camera, High Speed

"Magnifying Time", a new folder describing high-speed camera capable of 1000 to 3000 pictures per second. Particularly adaptable for close inspection in machine tool operations and also for measuring flow of liquids as in chemical mixers, coolant flow, etc. *Eastman Kodak Co.*

433. Camera Microscope

Complete information on construction, operation and special features of MEF universal metallurgical camera microscope. *Wm. J. Hacker & Co., Inc.*

434. Carbide Bits

Safety and savings by using tungsten carbide for machine and mine drill bits is subject of Dec. 1951 issue of "Bits of News". *Kennametal, Inc.*

435. Carbon Analysis

Bulletin 319 describes the Combustron, electronic induction heater in two or one-tube model for flexibility in analysis of low to high carbon content in alloy steel, cast iron and stainless steel. *Burrell Corp.*

436. Carbon and Graphite

New 20-page catalog describes and illustrates products made of carbon and graphite from porous to impervious for applications in metallurgical, mechanical, electrical, chemical and process fields. Many useful tables. *National Carbon Co.*

437. Carbon and Sulphur Analysis

Folder, punched for insertion in standard three-ring binder, describes induction furnaces for carbon and sulphur analysis. *Laboratory Equipment Corp.*

438. Carbon Test

Illustrated data discusses the melters carbon test for estimating the carbon content of molten steel in 40 sec. *Harry W. Dietert Co.*

439. Castings, Centrifugal

12-page illustrated bulletin on centrifugal castings of steel in permanent metal molds. *Lebanon Steel Foundry.*

440. Castings, Nickel Alloy Steel

32-page bulletin with over 100 illustrations reports on steel, cast to shape, as a reliable engineering material. Data on properties and applications of cast nickel steels are classified by industrial fields. *International Nickel Company, Inc.*

441. Castings, Nonferrous

Booklet available on sand and centrifugal bronze castings. *American Non-Gran Bronze Co.*

442. Castings, Steel

Pyrasteel bulletin describes chromium-nickel-silicon alloy for service economy in resisting oxidation and corrosion at temperatures to 2000° F. Also resists gases and most concentrated or dilute commercial acids. *Chicago Steel Foundry Co.*

Let Metaseal Help You

BOOST OUTPUT OF PRESSURE-TIGHT CASTINGS

. . . eliminate costly rejects due to porosity!

★ ★ ★

METASEAL CUSTOM IMPREGNATING SERVICE
uses newly perfected process
plus exclusive plastic impregnant

Now! Get your metal castings sealed so that they're pressure-tight, water-tight . . . save production costs . . . cut down rejects . . . with Metaseal's custom impregnating service for solid castings or pressure-tight assemblies.

24-HOUR SERVICE

Metaseal Impregnants and Process meet all military specs. Can be used on ferrous or non-ferrous metals including copper and copper alloys. Neither refrigeration nor inflammable solvents are required. Metaseal plastic impregnants are colorless . . . leave no stain . . . resist chemicals, solvents, glycols, alcohols, salts, aromatic fuels, etc. Write today!

WE WILL SET UP A COMPLETE PLANT FOR YOU UNDER AMC LICENSE PLAN

We are the only firm in the world equipped to set up a *complete* plant for sealing castings. Under our AMC Franchise plan we plan and install a complete setup, train your personnel, get the plant operating and oversee it for you. Write for full details.

amc **FREE!** *Information Bulletins on request*

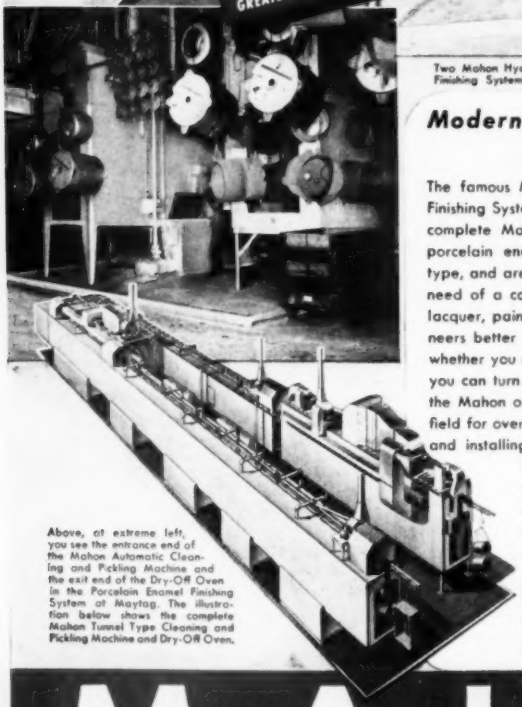
Metaseal *leads the field!*

AMERICAN METASEAL CORPORATION
607-609 SIXTY FIFTH ST., WEST NEW YORK, N. J.

COMPLETE Finishing SYSTEMS

. . . for ENAMELS • LACQUER • PAINT • VARNISH

Two Mahon Hydro-Filter Spray Booths in the air conditioned spray room of the Synthetic Enamel Finishing System at Maytag. Note Diffusers of the Filtered Air Supply System in the ceiling.



Above, at extreme left, you see the entrance end of the Mahon Automatic Cleaning and Pickling Machine and the exit end of the Dry-Off Oven in the Porcelain Enamel Finishing System at Maytag. The illustration below shows the complete Mahon Tunnel Type Cleaning and Pickling Machine and Dry-Off Oven.

Modern FINISHING EQUIPMENT at MAYTAG produces FINER FINISH!

The famous Maytag Appliances receive their fine lustrous finishes in Mahon Finishing Systems. In the modern Maytag plant at Newton, Iowa, there are two complete Mahon Finishing Systems—one for synthetic enamel, and one for porcelain enamel finishing. Both systems are of the Mahon "Self-Housed" type, and are models of efficiency in modern production finishing. If you are in need of a complete finishing system for either synthetic or porcelain enamel, lacquer, paint or varnish, you, like other manufacturers, will find Mahon engineers better qualified to advise you and to do your planning. Regardless of whether you require a complete new system or an individual unit of equipment, you can turn your problem over to Mahon with complete confidence, because the Mahon organization has pioneered development in this highly specialized field for over thirty years . . . the experience of planning, engineering, building and installing thousands of finishing systems, for every conceivable product in virtually every industry where finishing constitutes a major production operation, has endowed Mahon engineers with a wealth of technical knowledge and practical know-how not available to you elsewhere. See Mahon's Insert in Sweet's Mechanical Industries File for information, or write for Catalog No. A-652.

THE R. C. MAHON COMPANY

HOME OFFICE and PLANT, Detroit 34, Mich. • WESTERN SALES DIVISION, Chicago 4, Ill.

Engineers and Manufacturers of Complete Finishing Systems—including Pickling Equipment, Metal Cleaning and Rust Proofing Equipment, Dry-Off Ovens, Hydro-Filter Spray Booths, Filtered Air Supply Systems, and Drying and Baking Ovens, Hydro-Foam Dust Collectors, Dust Traps, Fog-Filters, and other Units of Special Equipment.

MAHON

443. Cemented Carbides

New catalog 51 gives latest information on carbide tooling. Contains completely illustrated details on all types of cutting tools, along with handy tables for grade selection and cutting speeds. *Kennametal, Inc.*

444. Cleaner

Technical specifications for surface active agent used with both acid and alkaline cleaners. *Alrose Chemical Co.*

445. Cleaner

Bulletins on Virgo descaling salt and Virgo molten cleaners. What they are, how they work, their advantages and how they fit into your operations. *Hooker Electrochemical Co.*

446. Cleaner

Bulletin 74-15 gives data on all-electric steam detergent cleaning. Pressures to 200 psi. *Livingstone Engineering Co.*

447. Cleaner

Product information folder gives data on industrial metal cleaners for use with water in either still tank or spray washing equipment. *Solvents Chemical Products, Inc.*

448. Cleaning Brushes

New booklet shows 12 actual case histories of how brushes provide thorough cleaning of welds, stainless sheet, hot cast iron, automotive parts, brass fixtures and others. *Pittsburgh Plate Glass Co., Brush Div.*

449. Cleaning and Buffing

Bulletin 44 contains an interesting discussion of barrel deburring, as well as methods of removing many kinds of burrs from sawing, drilling, milling and stamping operations. *Magnus Chemical Co.*

450. Cleaning and Finishing

Attractive 12-page, well-illustrated catalog A-652 gives the complete story on planning industrial finishing systems and shows many installations of cleaning and pickling machines operating in large metalworking plants. *R. C. Mahon Co.*

451. Cold Heading Brass Wire

"Chase Cold Heading Extruded Brass and Copper Alloy Wire" booklet gives physical and fabrication properties, applications, weights per 1000 ft. and ft. per lb. *Chase Brass & Copper Co.*

452. Compression Testing

Four-page folder on machines for compression testing of sheet metal, rivets, springs, welds. *Labquip Corp.*

453. Continuous Sampling

4-page descriptive and illustrative bulletin on continuous sampling monitor—a new device to simplify quality control. Explains operation, construction, range. *General Electric Co.*

454. Controllers, Temperature and Pressure

Bulletin 1320 tells about self-operated temperature and pressure controllers designed for accurate temperature regulation. Illustrated. Many industrial applications. *Taylorbue Instruments Div.*

455. Control Instrument

Direct reading spectrometer described in bulletin 34 is calibrated and adjusted to the particular analytical need of each user. Analysis of as many as 12 elements read directly and simultaneously from clock dials. *Baird Associates, Inc.*

456. Controls

Automatic controls for temperature, flow pressure, liquid level, humidity, pH value and described in Bulletin A120. *Bristol Co.*

457. Controls

Specification sheet 609 describes Electri-O-Vane control thermometer, having snap action electronic control. *Minneapolis-Honeywell Regulator Co.*

458. Copper Alloys

Illustrated, 24-page publication, B-14, on tools for screw machine use includes physical constants and properties of 46 free-cutting and general-purpose rods. *American Brass Co.*

459. Corrosion-Inhibiting Metal Waxes

Data sheet of physical characteristics and application methods for solvent-type and emulsion-type metal waxes for protective finishes. *S. C. Johnson & Son, Inc.*

460. Cutting Oil

Facts on more efficient and economical plant operation through use of right lubricants described in "Metal Cutting Fluids" booklet. *Cities Service Oil Co.*

461. Cutting Oil

4-page bulletin to aid in the selection of the proper straight cutting oil or base for specific operations. *E. F. Houghton & Co.*

462. Cutting Oil

Shop Notebook giving important facts on right cutting fluid for any machining operation. *D. A. Stuart Oil Co.*

A Royal Flush in Die Steels . . .

HARGUS . . . . . Oil Hardening Die Steel
Good Machinability, Minimum Deformation

WIZARD . . . . . Unbreakable Tool Steel, Truly "Unbreakable to the Maximum"

DARWIN & MILNER'S
PRK33 Cobaltcrom . . Air Hardening Die Steel
Maximum Production Runs

DARWIN & MILNER'S
NEOR . . . . . Original High Carbon High Chrome
Maximum Production Runs

DUMORE . . . . . Air Hardening
For Utmost Safety in Hardening

There's a ZIV STEEL Warehouse or representative near you. Call on your nearest one for prompt, courteous and dependable service.

FREE: SEND FOR NEW TOOL STEEL CATALOG.

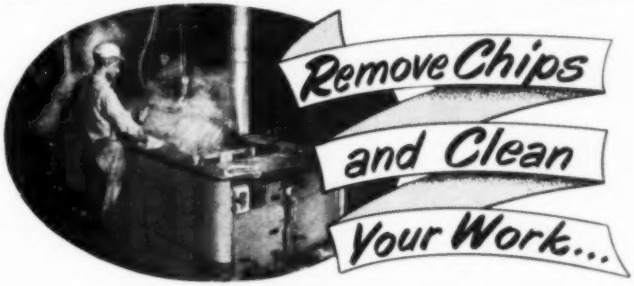
ESTABLISHED 1911

ZIV STEEL & WIRE CO.

2945 W. HARRISON STREET • CHICAGO 12, ILL.

BRANCHES

14643 MEYERS ROAD, DETROIT 27, MICH. • 1617 N. SEVENTH STREET, ST. LOUIS 6, MO.
3731 W. HIGHLAND BLVD., MILWAUKEE 8, WIS. • 633 FULTON ST., INDIANAPOLIS 2, IND.
1053 CUSTER DRIVE, TOLEDO 12, OHIO • EAGLE RIVER, MICHIGAN



...IN ONE OPERATION!

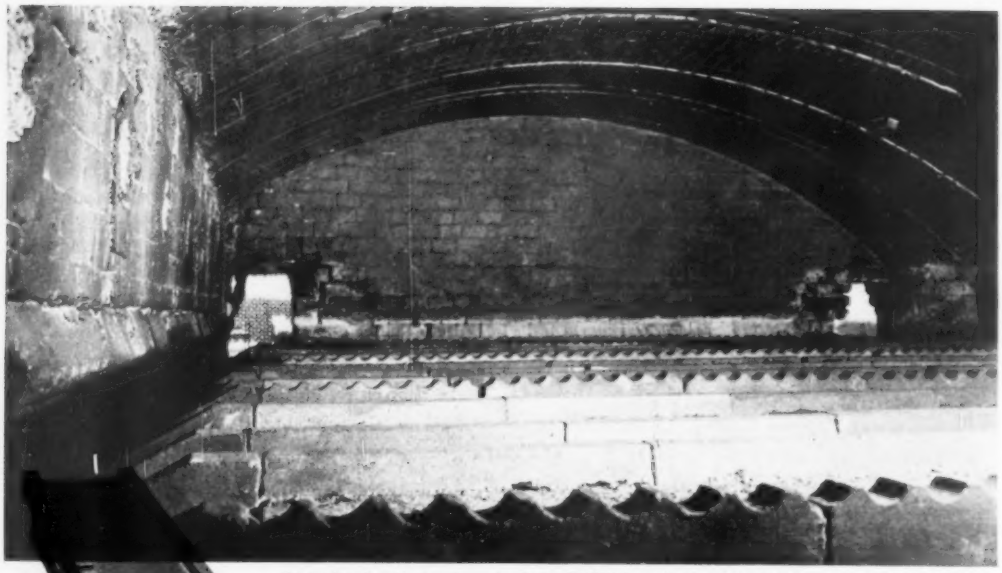
Removal of metal chips from machined parts by ordinary cleaning methods is, in most cases, a real problem. As parts are usually small, and handled in bulk, spray cleaning machines are inadequate because the sprays of cleaning solution do not penetrate into the mass of parts to remove the chips. In degreasers, cutting oils and the like are removed, but the chips remain.

Complete chip removal and cleaning are accomplished in the Magnus Aja-Dip Cleaning Machine. The batches of parts are vigorously agitated up and down in the cleaning solution 54 times a minute. The turbulent motion scrubs the parts clean of metal chips, oils and dirt—even down in the center of the load. Cleaning is automatic—one man is needed only to load and unload the machine. Ideally suited for production line cleaning.

Magnus Aja-Dip Machines are available in standard sizes handling batches of from 75 to 2200 lbs.—for cold or heated solutions. Write or telephone for further information.

MAGNUS CHEMICAL CO. • 96 South Ave., Garwood, N. J.
In Canada—Magnus Chemicals, Ltd., Montreal.
Service representatives in principal cities.

Magnus
CLEANERS • EQUIPMENT • METHODS



This is a Holcroft walking beam furnace (gas fired to 2000-2200 F) in which bars weighing 10-15 lbs. each are heated prior to forming.

"CARBOFRAX" work-rests outlast ALLOY 6 to 1

MATERIAL	REPAIRED	REPLACED	COST
ALLOY WORK-RESTS	Every 1-4 weeks	Every 4-6 months	Initial cost of alloy was more than twice as much as "Carbofrax" work-rests.
"CARBOFRAX" WORK-RESTS	None required	10% after 24 months. Completely replaced after 36 months.	

CARBOFRAX silicon carbide refractories are among the hardest of man made products. Used for work-rests, skid rails or other furnace applications where abrasion is severe, they will almost always outperform metals.

In this walking beam furnace, for example, the scalloped work-rests which support the bars were originally made of heat resisting alloy. These rests had to be repaired and straightened almost every week. And, of course, the furnace had to be shut down each time. Complete replacement was required every 4-6 months.

When replaced with CARBOFRAX work-rests, NO maintenance was required *for two full years*. Then, another 12 months uninterrupted service was obtained with only 10% replacement. And the *initial* cost of the CARBOFRAX rests was less than half the cost of the alloy!

Viewed in terms of reduced down time, labor savings, and over-all material savings, you can imagine the sizeable dividends these CARBOFRAX rests are paying.

Use Super Refractories by

CARBORUNDUM

Trade Mark

Dept. C-32, Refractories Div. The Carborundum Co., Perth Amboy, N. J.

"Carborundum" and "Carbofrax" are registered trademarks which indicate manufacture by The Carborundum Company.

CARBON and SULFUR ANALYSIS with *Speed! Ease! Accuracy!*

TWO MINUTE CARBON DETERMINATOR
High degree of accuracy assured by: fan cooling gases, leveling to meniscus line, automatically maintaining atmospheric pressure, wide selection of carbon percentage scales. Accurate within 0.002% on low range burette.
THREE MINUTE SULFUR DETERMINATOR
Determination in accordance with A.S.T.M. specification accuracy within 0.002% inorganic or organic materials. Simple procedure.
HIGH-TEMPERATURE FURNACE
Sturdy construction with HIGHEST QUALITY insulation.

Use **3031D Boats and Zircotubes to reduce operating cost of analysis.**

Use Dietert-Detroit Carbon and Sulfur Determinators for Economical Analyses

Write to Dept. C-4 for descriptive literature

CONTROL EQUIPMENT
HARRY W. DIETERT COMPANY
9330 ROSELAWN • DETROIT 4, MICH.

463. Cutting Oil System

Illustrated booklet gives data and charts on new cutting oil, dispensing jet and motor driven pump. Contains test results of overhead flood with conventional coolants vs. new twin development. *Gulf Oil Corp.*

464. Cut-Off Wheels

6-page folder gives data, operating suggestions and grade recommendations of cut-off wheels for delta machines. *Manhattan Rubber Div., Raybestos-Manhattan, Inc.*

465. Degreaser

Vapor degreaser OPNT described and diagrammed in folder. Data on different models. *Topper Equipment Co.*

466. Die-Casting Machines

New improvements in die-casting machines described in detail in Bulletin 23-I. Illustrations, specifications, application data and production advantages of patented features. *Lake Erie Engineering Corp.*

467. Die Steel

Booklet, "Die Steels for Hot Work", helps in selection of best grade for your particular job. *Vanadium-Alloys Steel Co.*

468. Dipping Baskets

Catalog B-J illustrates and describes various kinds of dipping baskets and other processing carriers. *Rolock, Inc.*

469. Drawing Compounds

Folder describes new type of lubricant for cold forming and drawing of stainless steel, both austenitic and ferritic. *Hangsterfer's Laboratories, Inc.*

470. Electric Air Heaters

4-page folder available on portable and built-in electric air heaters used in every industry and business. *Edwin L. Wiegand Co.*

471. Electric Furnaces

Bulletin No. 473 describes rocking, automatic melting machine for various ferrous and nonferrous alloys. *Detroit Electric Furnace Div.*

472. Electric Furnaces

Illustrated brochure gives data on electric heat treating furnaces, melting furnaces, metallurgical tube furnaces, research furnaces and sintering furnaces. *Pereny Equipment Co.*

473. Electric Ovens

Data sheet displays new industrial portable high temperature electric ovens. Illustrated. *Grieve-Hendry Co., Inc.*

474. Electric Salt Bath Furnaces

Illustrated folders give data on salt bath furnaces for batch-type work and conveyorized-type work. *Upton Electric Furnace Co.*

475. Electrode Holders

Data sheets illustrate and describe complete line of electrode holders. Include price lists. *Wagner Manufacturing Co.*

476. Electron Microscope

Specifications for new Philips electron microscope EM-100. *North American Philips, Inc.*

477. Electroplating

27-page "Four Good Steps Toward Better Electroplating on Steel" is helpful toward obtaining superior cleaning of both low-carbon and high-carbon steel. *Oakite Products, Inc.*

478. Extruded Aluminum

40-page illustrated brochure on use of extruded aluminum for moldings and other applications. *Youngstown Manufacturing, Inc.*

479. Fasteners

Descriptive and illustrative 17-page bulletin on types, sizes and applications for rivets and riveting tools. Many useful engineering charts. *B. F. Goodrich Co.*

480. Fasteners

Three color, 56-page price list and stock book for complete line of fastenings in brass, bronze, copper, Monel, aluminum, stainless steel. *H. M. Harper Co.*

481. Ferro-Alloys

"Electromet Products and Service" gives helpful information about the use of ferro-vanadium and other alloying metals. *Electro Metallurgical Co.*

482. Finishes

New 4-page, two-color bulletin describes in detail the entire line of Iridite finishes for nonferrous metals. Also includes section ARP process chemicals such as bright hardeners for zinc and cadmium plating and other specialties. *Allied Research Products, Inc.*

483. Finishes

New brochure gives full details on Black Magic Type A, blackening process for iron and steel. *Mitchell-Bradford Chemical Co.*

Available *for the first time...* **a Full-Color Sound Film**

STEEL WITH A THOUSAND QUALITIES

Scientific schools and groups of designers, engineers, metallurgists and technical societies can *now* secure the *free* use of this full-color sound film, the first produced in the steel foundry industry. Available in 16 mm prints, the film is a 37-minute tour of the modern plant of Lebanon Steel Foundry. The camera follows jobs from the blueprints on the project engineer's desk through steps of production to show, finally, a few of the many important uses of Lebanon quality Steel Castings. Write for information on this exciting and educational film.

LEBANON STEEL FOUNDRY
Dept. H, Lebanon, Pa.
In the Lebanon Valley

LEBANON ALLOY AND STEEL **castings**

Tops for:

- ★ HARDNESS
- ★ LONG WEAR
- ★ TENSILE STRENGTH
- ★ MACHINABILITY

. . . And tops for use in a long list of machine parts and tools.

Over 200 tube sizes from .898″ O.D. to 8.250″ O.D. Bar sizes from .171″ round to 7.5″ round. Also Ring Forgings.

Write for a copy of our latest stock list today.

PETERSON STEELS, INC.

DEPT. M, SPRINGFIELD ROAD, UNION, N. J.

DETROIT, MICH. • CHICAGO, ILL.

ACCURATE...

to ± 1.5 pts. ROCKWELL!
to ± 5 pts. BRINELL!

NOW! At-the-job, direct readings of all metal types, sizes and shapes. Quick and simple . . . just press handgrips, read dial. Unskilled labor can test assembly line work. No conversion scales, no calculations! Ideal for parts, finished products regardless of how large or small. Rockwell "A", "B", "C" scales. Low and medium Brinell scales. Both standard and superficial readings in one instrument!

WRITE NOW FOR BULLETIN ET301

MANUFACTURED IN THE UNITED STATES

NEWAGE INTERNATIONAL, INC.

235 EAST 42nd STREET, NEW YORK 17, N. Y.

METALS?

contact BELMONT for *Better Substitutes*

Belmont "Metal-of-the-Month" letters containing market news and other helpful information . . . yours by writing.

Keeping abreast of the latest technological advances in alloy improvements and metal uses is a full time job — as hard lines manufacturers well know. Current shortages and restrictions only make the task more complicated . . . and more urgent! Let Belmont insure *your* production by suggesting an obtainable substitute for that scarce metal. Supplying the right metal at all times has been Belmont's full time job for the past half century.

Metals? ⇨ Contact Belmont — All Metals, All Alloys, All Forms — and BETTER SUBSTITUTES!

Putting Mettle into Metals since 1896

Belmont SMELTING & REFINING WORKS, INC.

303 Belmont Avenue, Brooklyn 7, N. Y.

Dickens 2-4900

ALUMINUM - ANODES - ANTIMONY - ARSENIC - BABBITT - BERYLLIUM - BISMUTH - BRASS
BRONZE - BRAZING ALLOYS - CADMIUM - CALCIUM - CERRO ALLOYS - CHROMIUM - COBALT - COPPER - DIE CAST METALS
FERRO ALLOYS - FLUXES - HARDENERS - IRON AND STEEL FILINGS - LEAD - LITHIUM - LOW MELTING ALLOYS - MAGNESIUM
MANGANESE - MERCURY - MOLYBDENUM - NICKEL - POWDERED METALS - All Metals - SEMI RARE METALS - SILVER

484. Flame Hardening

4-page illustrated folder features new giant-size flame hardener at company which can flame harden forgings in a range of 4 to 18 inches in diameter, up to 20 feet in length. *National Forge & Ordnance Co.*

485. Forging Machines

Bulletin 65-C describes economy and productivity of company's forging machine. *Ajax Manufacturing Co.*

486. Forgings

Catalog GI illustrating types of upset and hammer forgings manufactured for various applications. *The Commercial Shearing & Stamping Co.*

487. Forgings

New catalog 51 contains 80 pages covering such topics as type of forgings; where and how to use forgings; turnbuckle dimensions, strengths and related data. Well illustrated with tables and drawings. *Merrill Bros, Co.*

488. Forming Machine

Catalog and specifications for forming machine developed for short-run production work where the cost of dies would be prohibitive. *Kilham Engineering, Inc.*

489. Furnace, Atmosphere

Bulletin F-1 gives full description of versatile, controlled-atmosphere furnace for all steels from high carbon to high speed in range 1200-2800° F. *Delaware Tool Steel Corp.*

490. Furnace Controls

Instruments and controls for heat treating furnaces are described in bulletin 49-750. *Hays Corp.*

491. Furnace Equipment

New, 20-page booklet discusses application of electrical equipment to direct and submerged arc furnaces, for steel mills, chemical plants, foundries and nonferrous metal refineries. *Westinghouse Electric Corp.*

492. Furnaces

High temperature furnaces for temperatures up to 2000° F. are described in leaflet. *Carl-Mayer Corp.*

493. Furnaces

Eight sizes in gas or electric models as well as conveyorized and batch or pot-type furnaces in bulletin 84P. *Despatch Oven Co.*

494. Furnaces

6-page folder describes 18 typical installations of gas-fired and electric furnaces of various types, complete with specially designed equipment for bright annealing, scale-free hardening, carbon restoration, carburizing and production heat treatment. *Electric Furnace Co.*

495. Furnaces

Bulletin HD-850 describes new shaker hearth furnace used for bright carburizing, bright dry cyaniding or bright hardening of small parts in processing up to 150 lbs. per hour. *Hevi Duty Electric Co.*

496. Furnaces

Full information furnished on new gas-atmosphere high-production furnace for handling bright annealing of wire, strip and bar stock of copper and nonferrous copper alloys. *Holcroft & Co.*

497. Furnaces

Complete "Buzzer" catalog available describing Buzzer high-speed gas furnaces designed primarily for heat treating high carbon and alloy steels and also atmospheric pot hardening furnaces for salt, cyanide and lead hardening. *Charles A. Hones, Inc.*

498. Furnaces

Catalog W-2 for descriptive matter on tool hardening equipment Model YP (vertical type) and Model ZV. *Sentry Co.*

499. Furnaces, Rotary Hearth

Folder giving drawings, dimensions, capacity, Btu, required for drawing, annealing, forging. *The Gas Machinery Co.*

500. Galvanizing

Reprint "Modern Hot-Dip Galvanizing" deals with dross formation as a cause of zinc waste. Detailed information on zinc ammonium chloride type of flux. *Hanson-Van Winkle-Munning Co.*

501. Gas Analysis

Theory of gas analysis, procedures involved in various analyses and instructions on maintaining and operating equipment are discussed in 60-page manual. *Fisher Scientific Co.*

502. Grinders

Catalog No. 75 describes bench and floor-type wheel grinders, polishing lathes and backstands of various sizes and capacities. *Hammond Machinery Builders, Inc.*

503. Grinding Machinery

Catalog 514 contains 28 pages of data and illustrations on continuous grinding machinery for fine grinding of innumerable metals. *The Patterson Foundry and Machine Co.*

504. Grinding Titanium

Article on grinding wheels and techniques for titanium, from "Grits and Grinds". *Norton Co.*

505. Hardfacing

New wall chart which details the proper hardfacing rod for the job. *American Manganese Steel Div.*

506. Hardfacing

New 40-page booklet "Haynes Alloys — Hard-Facing Manual" tells what metals can be hardfaced, how to select right hard-facing material, lists step-by-step application procedures and industrial applications. *Haynes Stellite Co.*

507. Hardfacing Rods

Five bulletins cover company's complete line of hard-facing alloy rods. *Victor Equipment Co.*

508. Hardness Tester

Bulletin F-1689-1 tells of the Impressor, hardness tester for aluminum, copper, brass, bronze and plastics. *Barber-Colman Co.*

509. Hardness Tester

4-page folder gives data on pocket-size hardness testing instrument. *Peabody Industries.*

510. Hardness Tester

Bulletin DH-114 contains full information on Tukon hardness testers for use in research and industrial testing of metallic and nonmetallic materials. Also included is bulletin DH-7, outlining experiences in various fields. *Wilson Mechanical Instrument Co.*

511. Hardness Tester

Illustrated circular describes portable hardness tester in sizes for work 1 in. to 6 in. round and flat. *Ames Precision Machine Works.*

512. Heat Control

Bulletin 4257 describes Pyrocon for quick, accurate reading of surface temperatures of molds, revolving rolls, bearings and other materials. Also outlines a wide selection of thermocouples and extension arms for laboratory service. *Illinois Testing Labs.*

513. Heat Exchangers

Bulletin No. 35-76C and illustrated folder No. 250 discuss equipment for use in quenching operation and other uses. *American District Steam Co.*

514. Heat Processing

New bulletin answers questions: what is to be heated, what sections are to be heated, why the material is to be heated, to what temperature, the heating time. *Selas Corp. of America.*

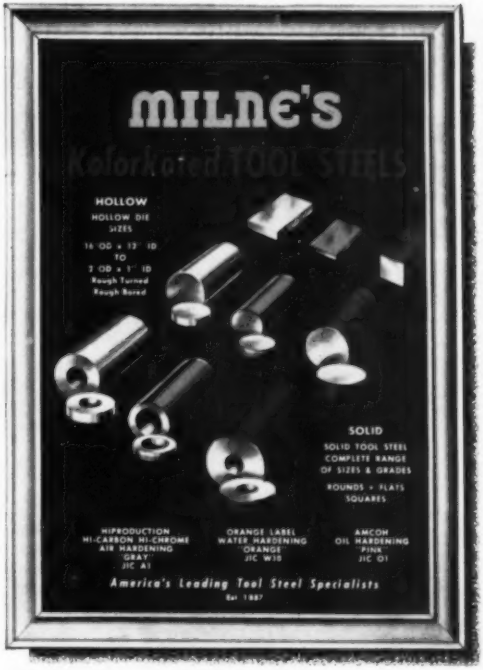
HOW MILNE CAN BRIGHTEN YOUR TOOL STEEL PICTURE

...with these three cost-reducers

1 Entire length Kolorkoted for permanent, quick-as-a-glance identification . . . eliminates confusion.

2 Heat treat card of color to match Kolorkote on steel goes with every shipment . . . eliminates errors.

3 Hollow Die Steels with smooth finish inside and out, no scale, no decarb . . . minimize machining, reduce waste. Saw cut to length.

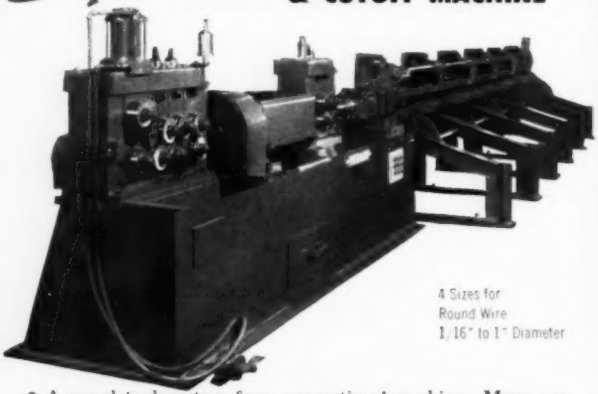

MILNE'S
Kolorkoted TOOL STEELS
HOLLOW
HOLLOW DIE SIZES
16 OD x 12" ID TO 3 OD x 1" ID
Rough Turned
Rough Bored
SOLID
SOLID TOOL STEEL COMPLETE RANGE OF SIZES & GRADES
ROUNDS • FLATS SQUARES
HIPRODUCTION HI-CARBON HI-CHROME AIR HARDENING GRAY JIC A1
ORANGE LABEL WATER HARDENING ORANGE JIC W10
AMCOH OIL HARDENING PINK JIC O1
America's Leading Tool Steel Specialists
Est. 1887

Visit Us At Booth 120 During The ASTE Show—Chicago, March 17th through March 21st.

A New & Different Fully Automatic Wire Straightener!

MEDART

Supermatic WIRE STRAIGHTENING & CUTOFF MACHINE



4 Sizes for Round Wire 1/16" to 1" Diameter

- A complete departure from conventional machines. More compact and accurate, with throughput speeds to 200 f.p.m. depending upon size and type of material.
- Fully automatic feed-through, straightening and cutoff, without attention from operator, after end of coil is started through pinch rolls.
- All swelling or expansion of workpiece is prevented by new HYDRA-ELECTRIC AUTOMATIC CUTOFF. Electronic self-actuating shear eliminates all mechanical operating parts beyond Cutoff. Makes up to 60 cuts per minute.
- Exclusive ROTO-DIE SPINNER is equipped with cylindrical straightening dies mounted in anti-friction bearing, instead of ordinary cast iron shoe-type dies. Virtually all friction, heat and rapid die wear are prevented. Protects against changes in physical characteristics and surface of wire.
- Automatic scale removal from hot-rolled stock.
- Rugged construction. Timken bearings throughout. Ground and polished Smavroc steel rolls. All mechanism completely accessible for maintenance.

Supermatic fully automatic two-plane models for wire shapes other than round also available.

Write For Brochure

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MISSOURI

515. Heat Treating

Barrett standard anhydrous ammonia is available in 150, 100 and 50-pound cylinders in conveniently located stock points. Send for literature. *Barrett Div., Allied Chemical & Dye Corp.*

516. Heat Treating

Ipsenlab periodic sheets show case histories on bright hardening, annealing and carburizing. *Ipsen Industries, Inc.*

517. Heat Treating

Data Sheet lists complete line of heat treat services available at plant. *Vincent Steel Process Co.*

518. Heat Treating

4-page folder lists hardening and annealing services available for manufacturers of products and users of equipment made of stainless steel. *The Drever Co.*

519. Heat Treating Equipment

Bulletin 820 gives detailed description with complete specifications on various size automatic quenching tanks for use with continuous heat treating equipment. *American Gas Furnace Co.*

520. Heat Treating Fixtures

Information on complete line of standard carburizing carriers that will handle odd-shaped parts of every type thru carburizing and quenching to finishing. *Pressed Steel Co.*

521. Heat Treating Furnaces

Information available on mechanized batch-type controlled atmosphere furnaces for gas cyaniding, gas carburizing, clean hardening or carbon restoration work. *Dow Furnace Co.*

522. Heat Treating Furnaces

Performance charts on fuel fired or electric heat treating furnaces for hardening, tempering, annealing, normalizing, stress relieving and aluminum treating. Furnace design incorporates both convection and radiant methods of heating. *Standard American Engineering Co.*

523. Heat Treating Furnaces

Illustrated literature describes newest developments in gas and electric heat treating furnaces. *Westinghouse Electric Corp.*

524. Heating for Brazing and Annealing

8-page, illustrated bulletin on high speed heating equipment for brazing, flame annealing, flame hardening, selective heating, and heating for forming. *Gas Appliance Service, Inc.*

525. Heating Forging Billets

Bulletin SC-144 tells of high speed, uniform and automatic heating which make automatic forging possible. *Surface Combustion Corp.*

526. High Temperature Alloy

Preliminary bulletin describes "Incoloy", new nickel-chromium alloy for high temperature and corrosive environments. *International Nickel Co., Inc.*

527. Hydraulic Presses

Bulletin 147, "Practical Facts About Hydraulic Presses", an informative guide for the user of all types and sizes of hydraulic presses. *Lake Erie Engineering Corp.*

528. Identifying Metals and Alloys

Booklet of procedures for rapid identification of more than 125 metals and alloys. *The International Nickel Co., Inc.*

529. Identifying Stainless Steel

Cardboard chart outlining systematic method for rapid identification of unknown or mixed stocks of stainless steels. *Carpenter Steel Co.*

530. Immersion Heating

Bulletin IE-11 gives complete details on how new immersion pots save time and money in melting soft metals. High thermal efficiency for both large and small units provides rapid heat recovery in one-third the time. *C. M. Kemp Mfg. Co.*

531. Immersion Pyrometry

Folder N 33-640 (1) presents both immersion thermocouple and immersion rayotube equipment for molten steel temperature measurement in 275-ton openhearth furnaces down to 1000-lb. high-frequency induction furnaces. *Leeds & Northrup Co.*

532. Impregnating Castings

Folder on six-step impregnation process to eliminate porosity in castings. Includes data on impregnating material. *American Metaseal Corp.*

533. Impregnating Castings

Literature on new impregnating equipment for elimination of porosity in ferrous and nonferrous castings. *Metallizing Co. of America.*

534. Induction Heating

New bulletin "Induction Heating and Melting" contains the well-known Selector Chart and table giving heating and melting speeds for standard induction equipment. *Ajax Electrothermic Corp.*

535. Induction Heating

4-page, two-color bulletin describes new heat treating machine for handling parts to be induction hardened progressively. *General Electric Co.*

536. Induction Heating

Bulletin giving specifications for electronic heater with frequency of 400,000 cycles. *Lewis Machine Co., Inc.*

537. Induction Heating

Bulletin 1440 furnishes full details on the "Checklite" system for safety control through the use of oversized components built into every unit for longer service life and uninterrupted production. *Lindberg Engineering Co.*

538. Induction Heating

Illustrated bulletin on new 60-cycle induction furnace for heating aluminum, magnesium, copper and brass for forging, extrusion and rolling. *Loftus Engineering Corp.*

539. Induction Heating

General data folder informs concerning megacycle tube-type machines for soldering, brazing, bombarding, annealing and hardening. Fully illustrated. *Sherman Industrial Electronics Co.*

540. Induction Heating

"Induction Heating . . . the machine tool that makes tall stories come true" presents case histories of how induction heating has increased production, reduced space and cut production costs. *Westinghouse Electric Corp.*

541. Induction Melting

8-page illustrated article describes use of induction melting in improved technique for rotor-casting. *Ajax Engineering Corp.*

542. Industrial X-Ray

New catalog on "Industrial X-Ray Accessories" provides complete listing of this equipment, including chemicals, dark-room accessories, filing equipment, processing tanks, dryers and radiation instruments. *Picker X-Ray Corp.*

543. Inspection Light

Literature available on instrument that spotlights the work and magnifies it at the same time. For inspection. *E. W. Pike & Co.*

544. Instrument Panels

Bulletin P1-2 lists and describes a complete line of cabinet-type instrument panels. *Wheelco Instruments Co.*

545. Instruments

Electronic temperature recorders and controllers are described in catalog No. P1245. *Bristol Co.*

546. Instruments

New, 28-page catalog No. 8000 describes the principal instruments, control devices and related components manufactured by the company. *Minneapolis-Honeywell Regulator Co.*

547. Insulation

New 4-page folder on Superex block insulation tells economical advantages and lists outstanding properties by means of conductivity and heat loss graphs and recommended thickness table. *Johns-Manville.*

548. Iron, High Chromium

New booklet, "Abrasion-Resistant High-Chromium Iron", furnishes a complete file of the best available information on how to make and use abrasion-resistant iron castings most efficiently. *Electro Metallurgical Co.*

549. Iron-Nickel Alloys

32-page bulletin with over 20 tables and charts on austenitic iron-nickel alloys having special thermal expansion or thermoelastic characteristics. *International Nickel Co., Inc.*

550. Laboratory Equipment

Data available on complete line of spectrographic equipment. *National Spectrographic Laboratories, Inc.*

551. Laboratory Furnaces

Series of data sheets give full information on complete line of laboratory furnaces for numerous metallurgical operations. *Boder Scientific Co.*

552. Lapping Machines

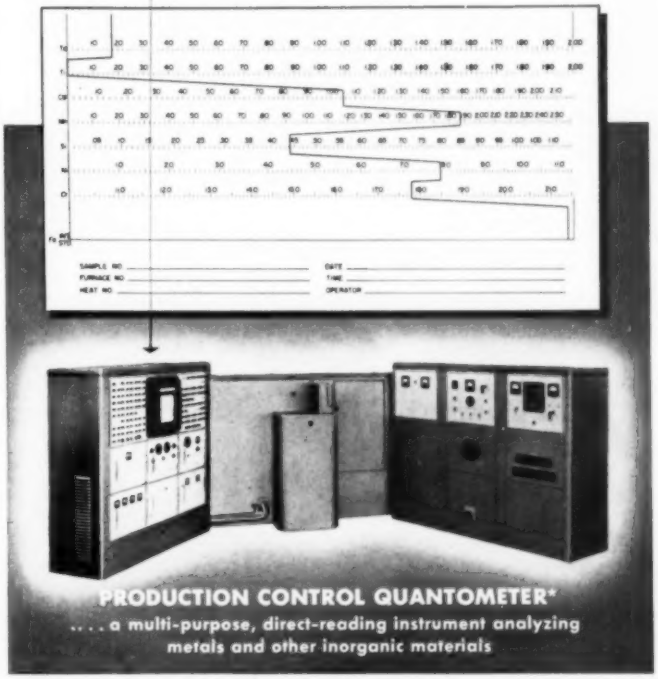
16-page booklet offers charts, illustrations and data on machines for automatic precision lapping of all materials in any production quantity. *Crane Packing Co.*

553. Lithium in Copper

Data available on effect of lithium on electrical conductivity and porosity of copper and its alloys. *Metalloy Corp.*

THE INSIDE STORY ON STAINLESS STEEL

Shown below is a multiple-copy graphic record of a typical stainless steel chemical analysis made on an ARL Production Control Quantometer.* Accurate percentages of elements present in the alloy are recorded permanently in pen-and-ink in less than two minutes! And steel is only one of many metals and inorganic compounds which the unique ARL Quantometers are controlling daily as to routine chemical analysis in many types of industries.



PRODUCTION CONTROL QUANTOMETER*
. . . . a multi-purpose, direct-reading instrument analyzing metals and other inorganic materials

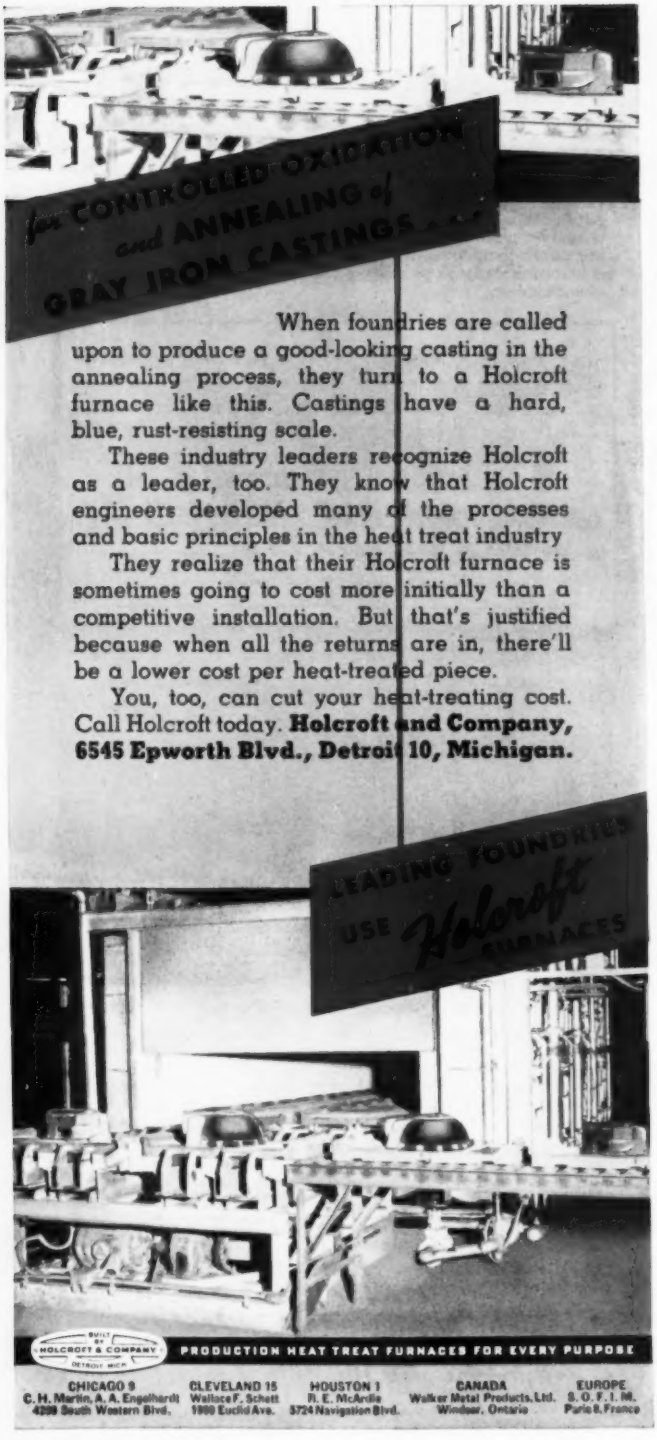
The ARL Quantometer is extremely efficient, versatile and applicable to a wide variety of needs. Individual units are not limited to a single type of analysis, but can be designed to meet the requirements of many plant problems. As many as 25 elements as selected by the user can be accurately measured on the Production Control Quantometer—up to 20 simultaneously!

This instrument, pioneered and perfected by ARL engineers, is invaluable in helping to speed the production of critical materials and improving laboratory controls. It is the most advanced type of spectrometer yet developed and deserves your most serious consideration. Write for descriptive brochure.

THE ARL LINE ALSO INCLUDES 1.5 AND 2-METER SPECTROGRAPHS, PRECISION SOURCE UNITS, RAMAN SPECTROGRAPHS AND RELATED ACCESSORIES.

Trademark*

Applied Research Laboratories
SPECTROCHEMICAL EQUIPMENT
3717 PARK PLACE • GLENDALE 8, CALIFORNIA
NEW YORK • PITTSBURGH • DETROIT • CHICAGO • LOS ANGELES


for CONTROLLED OXIDATION and ANNEALING of GRAY IRON CASTINGS
When foundries are called upon to produce a good-looking casting in the annealing process, they turn to a Holcroft furnace like this. Castings have a hard, blue, rust-resisting scale.
These industry leaders recognize Holcroft as a leader, too. They know that Holcroft engineers developed many of the processes and basic principles in the heat treat industry
They realize that their Holcroft furnace is sometimes going to cost more initially than a competitive installation. But that's justified because when all the returns are in, there'll be a lower cost per heat-treated piece.
You, too, can cut your heat-treating cost. Call Holcroft today. Holcroft and Company, 6545 Epworth Blvd., Detroit 10, Michigan.
LEADING FOUNDRIES USE Holcroft FURNACES
BUILT BY HOLCROFT & COMPANY DETROIT MICH.
PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE
CHICAGO 9 C. H. Martin, A. A. Engelhardt 4209 South Western Blvd.
CLEVELAND 15 Wallace F. Schott 1900 Euclid Ave.
HOUSTON 1 R. E. McArdle 5724 Navigation Blvd.
CANADA Walker Metal Products, Ltd. Windsor, Ontario
EUROPE S. O. F. I. M. Paris 8, France

554. Load Testing

Brochure 501 gives full details on universal testing machines in three ranges: Model TMU-A, 0–30,000, 0–6000, 0–600 lbs.; Model TMU-B, 0–15,000, 0–3000, 0–300 lbs. *National Forge & Ordnance Co.*

555. Lubricants

Bulletin 93 has case histories describing successful use of Molykote in various industrial applications. *The Alpha Corp.*

556. Lubricants

New, 40-page booklet on Moly-sulfide, solid film lubricant, records experience with 154 different applications. *Climax Molybdenum Co.*

557. Lubricants

Bulletin No. 10-21 describes series of drawing and stamping lubricants. *Forbes Corp.*

558. Lubricants, Metal Forming

Well-illustrated brochure showing eight difficult parts stamped, blanked or drawn, using wax lubricants. Metals include aluminum, deep drawing steel, 430 and 446 stainless, and electrical sheet. *S. C. Johnson & Son, Inc.*

559. Lubrication, Metalworking

The uses of colloidal graphite for hot metalworking operations (deep piercing, casting, forging, stretch-forming and wire drawing operations) are explained in bulletin No. 426-10C. *Acheson Colloids Corp.*

560. Machining

New 16-page illustrated catalog explains the advantages and manufacturing short cuts possible by contour machining with band tooled machines. *DoAll Co.*

561. Machining Stainless Steel

Revised edition of fabricating manual lists grades with analyses and individual descriptions of grade characteristics. Recommended machine speeds for the extra low-carbon grades. *Armco Steel Corp.*

562. Magnesium Die Castings

Book, "How Magnesium Pays", gives case studies of the economical uses of magnesium in a wide range of products. *Dow Chemical Co.*

563. Magnets

A 12-page catalog describes line of magnetic separators and lifting magnets. *Dings Magnetic Separator Co.*

564. Magnets

Illustrated catalog, Bulletin PM-100, lists stocked sizes and shapes of Alnico permanent magnets. *Carboloy Dept., General Electric Co.*

565. Marform Deep Drawing

Catalog No. L-79-641 describes pressure control mechanism for use in the Marform deep drawing process. *Lowey Construction Co.*

566. Metal Analysis

New brochure describes the operation of the ARL Production Control Quantometer which furnishes direct-reading, pen-and-ink records of quantitative spectrochemical analyses with extra copies, quickly and accurately. Up to 20 chemical elements measured simultaneously. *Applied Research Labs.*

567. Metal Analysis

Bulletin 220-F describes completely new mercury cathode, Dyna-Cath, that provides economical and high-speed separation of iron in determination of aluminum in steel. *Eberbach Corp.*

568. Metal Cutting

New 64-page catalog No. 28 gives prices and describes complete line of rotary files, burrs, metalworking saws and other products. *Martindale Electric Co.*

569. Metal Forming Machine

Six-page bulletin on machine for bending, folding and shaping of sheet and strip. *Kilham Engineering Sales Co.*

570. Metal Spraying

Article "Metallizing — What It Is, What It Does", in current issue of "The Metallizer". *Metallizing Co. of America.*

571. Metal Statistics

"Metal of the Month" letters, include market trends, statistics and other helpful data. *Belmont Smelting & Refining Works, Inc.*

572. Metal Supplies

Various thin-gage and clad metals as well as precious metal strip, wire and powder which are still available are listed in Bulletin 9-B. *American Silver Co., Inc.*

573. Metal Treating Ammonia

Booklets available on "Applications of Dissociated Ammonia", "Ammonia Installations for Metal Treating", "The Nitriding Process" and "Carbonitriding". *Armour & Co.*

Doubles Your Opportunity For More Yield Anytime

When your cold rolled strip steel delivers more feet per lb., more finished parts per ton, you gain a head start on controlled supply. That's exactly what CMP Thinsteel, in all grades, has been providing for many years. You see, oversize variation, bothersome source of footage loss in ordinary flat-rolled steel, is kept to the minimum by CMP's precision rolling processes. So, you can count on Thinsteel, anytime, free or controlled supply, to increase yield—give you improved production and better end-product quality. Of course, today, Thinsteel production is directed first to defense needs, but whether for defense or regular civilian end-use manufacture it is a helpful answer in stretching steel supply

CMP THINSTEEL

PRECISION COLD ROLLED CMP STRIP STEEL

the Cold Metal Products co.

YOUNGSTOWN 1, OHIO

New York • Chicago • Indianapolis • Detroit • St. Louis • Los Angeles • Cleveland

LOW CARBON, HIGH CARBON (Annealed or Tempered) *STAINLESS AND ALLOY GRADES, ELECTRO ZINC COATED ARE AVAILABLE FROM:*

THE COLD METAL PRODUCTS CO. of CALIFORNIA, 6600 McKinley Avenue, Los Angeles
Phone: PLeasant 3-1291

THE KENILWORTH STEEL CO., 750 Boulevard, Kenilworth, New Jersey
Phones: N. Y., COrtlandt 7-2427; N. J., UNionville 2-6900

PRECISION STEEL WAREHOUSE, INC., 4425 W. Kinzie, Chicago • Phone: COlumbus 1-2700

574. Metallograph

New research metallograph, described in catalog E-240, furnishes four different accurate images of same sample for complete identification with bright field, dark field or polarized light. *Bausch & Lomb Optical Co.*

575. Metalworking Data

Factual 52-page booklet contains defense production experience gained from WW II and supplement of latest manufacturing and processing techniques. *E. F. Houghton & Co.*

576. Metalworking Lubricant

Data sheet on solid waxes in stick form for use as lubricant in sawing, threading, drilling, tapping, spinning and grinding. *S. C. Johnson & Son, Inc.*

577. Microhardness Tester

Bulletin describes the Kentron microhardness tester. *Kent Cliff Laboratories.*

578. Microscopes

Well-illustrated 22-page catalog describes new line of laboratory microscopes featuring ball bearings and rollers throughout the focusing system and a low position fine adjustment, providing comfortable operation for high precision work. *Bausch & Lomb Optical Co.*

579. Modulus Determination

Data sheet on equipment for determination of modulus of elasticity by sonic method that measures resonance frequency of masses weighing up to 1500 lb. *Electro Products Laboratories, Inc.*

580. Nonferrous Castings

Eight pages of tabular data on standard brass, bronze, nickel silver, aluminum bronze, aluminum and zinc casting alloys, from December issue of Lavingot. *R. Lavin & Sons, Inc.*

581. Oil Quenching

Catalog V-1146 gives detailed information on self-contained oil coolers, together with easy selection tables. *Bell & Gossett Co.*

582. Oxygen Determination

Data Sheet No. 10.15-9 describes recording analyzer which provides an accurate record of oxygen measurement for the entire range of concentration from a few parts per million to 100% oxygen. *Minneapolis-Honeywell Regulator Co.*

583. Perforating Dies

Illustrated 40-page book gives diagrams, charts on set-ups for adjustable dies for perforating materials up to and including ¼ in. mild steel. *S. B. Whistler & Sons, Inc.*

584. Phosphate Treatment

8-page booklet describing a paint-anchoring corrosion-resistant phosphate treatment for metals, with separate discussion of typical products to which process can be applied. *Octagon Process, Inc.*

585. Photomicrography

Full information furnished on Aristophot camera with Ortholux research microscope, providing the perfect team for easy, inexpensive photomicrography and photomacrography. *E. Leitz, Inc.*

586. Piercing

A calculator of the slide-rule type for determining the required pressure (in tons) for piercing a given size hole in any thickness and type of metal. *Ward Machinery Co.*

587. Polishing and Buffing

Bulletin describes machines for every type of polishing and buffing job. *Acme Mfg. Co.*

588. Potentiometers

Dynalog instruments for control of temperature, humidity, pressure, flow, etc. Details in bulletin 427. *Foxboro Co.*

589. Power Brushes

New 76-page catalog simplifies selection of power brush for the individual job; contains numerous colored illustrations of various types of brushes in operation. *Osborn Mfg. Co.*

590. Precision Castings

8-page, illustrated brochure gives informative engineering data on precision castings produced by the Mercast process. *Alloy Precision Castings Co.*

591. Precision Castings

Illustrated folder, "Cost Reduction Through Investment Casting", shows diversity of parts to which process applies. *Casting Engineers, Inc.*

592. Precision Castings

Illustrated folder shows samples of investment castings produced of various ferrous and nonferrous alloys. Advantages of these castings. *Engineered Precision Casting Co.*

593. Protective Coating

Bulletin 600 on phenolic coating resin for protecting steel against corrosion. *Carboline Co.*

594. Pyrometer Supplies

Catalog 100-4 furnishes useful technical data on the application and use of thermocouple pyrometric supplies. *Minneapolis-Honeywell Regulator Co.*

595. Pyrometers

New circular gives complete information on Xactemp pyrometers. New Type LT-840 and all accessories are illustrated and described. Xactline straight-line temperature control for use with any standard pyrometer controller is described in a companion folder. *Claud S. Gordon Co.*

596. Pyrometers

Catalog No. 165 describes improved Pyro surface pyrometer. Eight instruments in one, it handles surface and sub-surface temperature measuring jobs. *Pyrometer Instrument Co.*

597. Pyrometers

Data sheets available on high resistance indicating pyrometers. Also pyrometer controls and resistance thermometers. *Taco West Corp.*

598. Quench Agitation

Information on mixers and agitators, including units applicable to industrial quenching equipment. *Mixing Equipment Co., Inc.*

599. Quenching

Newest developments of isothermal heat treat process in martempering, austempering and other interrupted quenching operations described in bulletin 120. *Ajax Electric Co.*

600. Quenching Additive

8-page brochure tells in detail how carbon steel often replaces alloy steel when additive is used in quenching oil. *Aldridge Industrial Oils, Inc.*

601. Quench Oil Cleaning

16-page brochure of case histories on economies obtained by oil purification. *Howan-Crane Corp.*

602. Recorder, Strip Chart

Bulletin C2 describes capacilog strip chart recorders that provide permanent record of temperature or other variables in industrial processing. *Wheelco Instruments Co.*

603. Refractories

New 20-page booklet gives technical information of a basic nature on super refractories. Text material is supplemented with charts, tables, illustrations and application data. *Carborundum Co., Refractories Div.*

604. Refractories

New 12-page illustrated brochure presents products for casting special refractory shapes and products for gunning and slap troweling applications, for services through 3000° F. *Johns-Manville.*

605. Refractories

Revised catalog section S-6210 covers carbon and graphite brick for application in the chemical, processing and metallurgical industries. *National Carbon Co.*

606. Refractory

Form 1409 describes the new Norton Fused Stabilized Zirconia, ideal refractory for furnace linings, metal melting, thermal insulation. Batts for firing Titanates and electric heater elements. *Norton Co.*

607. Resistance Thermometers

36-page catalog and buyers' guide for entire line of resistance thermometers. Includes 8-page tabular guide to selection. *Leeds & Northrup Co.*

608. Resistance Welding

6-page brochure "Spot and Seam Welding in Aircraft Construction" features Northrop Aircraft applications. *Sciaky Bros., Inc.*

609. Rod Selection Guide

Bulletin "SG" breaks down into basic operations the parts that can and should be hardfaced for longer life. Includes the part-name, the recommended rod, sizes and method of application. *American Manganese Steel Div.*

610. Rust Preventive

Technical information available on zinc p
phate type rust preventive conforming to sev
specifications. *American Chemical Paint Co.*

611. Salt Baths

32-page bulletin entitled "Houghton Li
Salt Baths" discusses the advantages of
process for tempering, brazing, annealing, har
ing, rehearting, and carburizing. Also cont
many pages of factual heat treating data. *H
Houghton & Co.*

612. Seamless Tubing

Technical Handbook No. M-1 covers mechat
tubing of various carbon and alloy steels.
Seamless Tube Co.

613. Shears

Bulletin 80F-A offers detailed information
operation of foot shears useful for numerous a
cations. *Niagara Machine & Tool Works.*

614. Shock Testing

4-page technical booklet describes use of s
testing mechanism (conforming to Specifica
No. JAN-S-44). Calculations, operation, and
strumentation. *Haines Designed Products C*

615. Silica Cement

Illustrated folder on use of silica cemen
laying silica brick in various types of furn
Harbison-Walker Refractories Co.

616. Silicone-Base Finish

New brochure on silicone-base heat-resi
finish is now ready. *Midland Industrial
ishes Co.*

617. Specimen Grinders

6-page booklet describes grinders and surf
designed for metallurgical samples. Both
and wheel types are offered for wet or dry g
ing. *Buehler Ltd.*

618. Specimen Mount Press

New bulletin describes AB Speed Press,
tures include use of preheated premolds,
closing and universal application for thermose
or thermoplastic materials in 3 sizes. *Buehler*

619. Spectrographs

A 52-page guide to spectrographic appa
for metallurgical and general chemical ana
Jarrell-Ash Co.

620. Spectrometer

New 60-page catalog covers X-ray diffra
spectrometry and fluorescence analysis and
ponents and accessories. *North American P
Co., Inc.*

621. Spray Booths

Bulletin has 15 pages of photos, diagram
information on hydro-whirl spray booths
sizes and arrangements for manual or auto
spraying. *Peters-Dalton, Inc.*

622. Stainless Castings

28-page full-color industrial fantasy, "Allo
Cooperland", captures the spirit of Lewis C
in describing how stainless steel castings are
The Cooper Alloy Foundry Co.

623. Stainless Spring Wire

Spring properties, applications, cost comp
among various spring metals as function of
diameter. *Alloy Metal Wire Co., Inc.*

**[• If mailed from countries outside the United States, pro
amount of postage stamps must be affixed for returning c**

FIRST
PERMIT
(Sec. 34.9
Clevelan

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In the United States

4c POSTAGE WILL BE PAID BY—

METAL PROGRESS

7301 Euclid Avenue

CLEVELAND 3, OHIO

...now

SAECO RADIVECTION

FUEL-FIRED OR ELECTRIC

HEAT TREATING FURNACES

FOR UTILITY AND PRODUCTION — HARDENING, TEMPERING, ANNEALING, NORMALIZING, STRESS RELIEVING, ALUMINUM TREATING, ETC.

★ TEMPER 2,000,000 lbs. *More Work* A Year Using Less Floor Space Than Any Convection or Other Draw Furnace Built.

★ Uses 25% less gas.

★ Let Your New Furnace Pay For Itself In Four Months *Through Increased Production.*

★ Improve Surface Appearance and Quality . . . Avoid Excess Scale and "Burned" Work.

Claims are based on 24-hour a day tempering at 1000° F. loading 75 pounds a cubic foot. *Denser loading improves RADIVECTION Advantage.*

Write for Verified Performance Charts . . .

. . . and Names of RADIVECTION Users

STANDARD AMERICAN ENGINEERING CO.

7851 W. 43rd Street, Lyons, Illinois

624. Stainless Steel

"Fabrication of 17% Chromium Stainless (Type 430)" includes illustrations of typical changes in die practice, weld structures, mechanical properties of fusion-welded joints and spot welds. *Armco Steel Corp.*

625. Stainless Steel

Weekly lists with analyses of all plates in stock and latest data. *G. O. Carlson, Inc.*

626. Stainless Steel

133-page "Working Data" book describes Stainless No. 10 and other stainless and heat resisting steels. *Carpenter Steel Co.*

627. Stainless Steel

8-page guide to Enduro stainless gives composition, physical, electrical and mechanical properties of 300 and 400 series. Corrosion data for 600 mediums. *Republic Steel Corp.*

628. Stainless Steel

New 16-page booklet "Armco Precipitation Hardening Stainless Steels" describes the advantages, corrosion-resistance, heat treatment and mechanical properties of Armco 17-4 PH and 17-7 PH stainless steels. *Armco Steel Corp.*

629. Stampings

Illustrated brochure on variety of stampings made by company. *The Commercial Shearing & Stamping Co.*

630. Steel Bars

New wall chart of 275 different grades of standard, special and alloy steel bars shows chemical analyses and other data. *LaSalle Steel Co.*

631. Steel, Low-Alloy

Booklet on Hi-Steel, which has nearly twice the working strength of ordinary steels plus the ability to stand up under impact loads. *Inland Steel Co.*

632. Steel, Low-Alloy

Well-illustrated 8-page folder on N-A-X low-alloy steels lists physical properties and test specifications. *Great Lakes Steel Corp.*

633. Straightening Presses

Folder on hydraulic straightening presses with capacities up to 25 tons. *Anderson Bros. Mfg. Co.*

634. Stud Welding

12-page manual prepared to aid designers and production engineers in the fast, economical solution of fastening problems. Specifications, selection guide included. *Nelson Stud Welding Div.*

635. Subzero Freezer

4-page folder on portable freezer, 110-volt a.c., operating to −180° F., for shrink fitting, hardening, stabilizing and testing. *Webber Appliance Co., Inc.*

636. Subzero Treatment

Advantages of low-temperature metal treatment are described in a new 8-page folder. Processes covered are for stabilization, increasing tool life and shrink-fit assembly. *Deepfreeze Distributing Corp.*

637. Temperature Control

New 52-page catalog covers design, operating characteristics and installation of each of 10 types of thermostatic devices. *Fenwal, Inc.*

638. Temperature Control

Revised 4-page leaflet, Data Sheet No. 6.4-2a, describes the application of tool temperature control to openhearth furnaces. *Minneapolis-Honeywell Regulator Co.*

639. Temperature Controller

Data sheet on compact input controller and indicating potentiometer, which can be set to regulate current input anywhere from 5 to 100% time on. *Thermo Electric Manufacturing Co.*

640. Temperature Regulator

Folder giving complete specifications of electrically operated two-position, on-off temperature regulators. *Barber-Colman Co.*

641. Testing

Folder on chemical, spectrographic, physical and metallographic services. *United States Testing Co., Inc.*

642. Testing Instruments

Brochure describing various testing machines — Brinell, ductility, compression, tensile, universal, etc. *Steel City Testing Machines, Inc.*

643. Testing Machine

32-page catalog lists all Riehle hydraulic universal testing machines. Illustrations, specifications, advantages, operating details. *American Machine and Metals, Inc.*

644. Testing Machine

Bulletin 40 contains full details on the new low-cost Super "L" testing machine with Select-o-Range indicating system. *Tinius Olsen Testing Machine Co.*

645. Textured Stainless

6-page illustrated folder on suggested uses for stainless metals to conserve strategic alloys and reduce weight for the armed forces. *Rigidized Metals Corp.*

646. Thermometers

New catalog 6020 describes compact approach to time-temperature control of operations such as annealing. Describes new instrument that combines as many as six functions from a standard sized instrument case. *Minneapolis-Honeywell Regulator Co.*

647. Tool Maintenance

New compact 72-page booklet gives instructions on maintenance of alloy and high speed cutting tools. *Abrasives Div., Carborundum Co.*

648. Tool Steel

Circle "M". Star-Mo and Van Chip are three high speed steels described in folders covering mechanical and heat treating data and applications. *Firth Sterling Steel & Carbide Corp.*

649. Tool Steel

Selector is handy chart featuring general and heat treating data on non-deforming, water hardening, shock-resistant, hot work and high speed tool steels and hollow die steels. *A. Milne & Co.*

650. Tool Steel

86-page pocket-size handbook on application and heat treatment of 22 grades of tool and die steels. *Ziv Steel & Wire Co.*

651. Tool Steel Color Guide

Color guide to estimate the temperatures of heated steels has heat colors on one side and temper colors on the other side. *Bethlehem Steel Co.*

652. Tool Steel Selector

Handy, clearly printed, easy-to-use tool steel selector will be furnished on request. *Crucible Steel Co. of America.*

653. Tube Fabrication

Concise case histories, production stories and equipment descriptions on tube fabrication from "Pine Engineering News". *Pines Engineering Co., Inc.*

654. Tube Furnaces

Bulletin No. 310 describes furnaces for determining carbon or sulphur in ferrous analysis and other similar procedures requiring continuous operating temperatures to 2650° F. *Burrell Corp.*

655. Tubes, Bars, Steel

New stock list now available on 52100 tubing and bars as well as ring forgings. *Peterson Steels, Inc.*

656. Tubing

New illustrated catalog shows typical applications of electrical weld steel mechanical tubing. Useful engineering charts. *Brainard Steel Co.*

657. Tubing

Technical discussion of fabrication and forging of steel tubing is given in Handbook No. F-8. *Ohio Seamless Tube Co.*

658. Turbo Compressors

New 12-page bulletin 126-A provides detailed information on application of turbo compressors to oil and gas-fired equipment used in heat treating, agitation, cooling, drying, gas boosters and pneumatic tube systems. Performance curves and tables of capacities for both vacuum and pressure applications are included. *Spencer Turbine Co.*

659. Vacuum Pumps

Illustrated data sheet describes and charts characteristics of new diffusion pumps and provides data on forevacuum, fractionation, speed, baffles and installation. *Distillation Products Industries.*

660. Vapor Degreasing

Pamphlet on properties and use of trichlorethylene as a solvent for vapor degreasing of metal parts. *Niagara Alkali Co.*

661. Vibration Testing

6-page folder of specifications and photos of 8 models of vibration fatigue testing equipment. *All American Tool & Mfg. Co.*

662. Wax Lubricant

Free sample and complete information on use of wax lubricant in difficult drawing and stamping operations. *S. C. Johnson & Son, Inc.*

663. Weld Rod, Hard Facing

4-page bulletin on applications for hard surfacing welding electrodes of 13½% manganese-nickel steel. *Stulz-Sickles Co.*

664. Welder, Bench

Bulletin DL-W-221 gives detailed description and technical data on new bench welder based upon an entirely new principle of operation. *Raytheon Manufacturing Co.*

665. Welding Alloys

New, 16-page, 1952 directory contains photographs, data and technical information on low temperature welding alloys and electrodes. *Eutectic Welding Alloys Corp.*

666. Welding Cable Connections

12-page Tweco log illustrates and describes complete line of electrode holders, ground clamps, cable connectors, terminal connectors, cable splicers and other products. *Tweco Products Co.*

667. Welding Electrodes

New 12-page booklet, "The ABC's of Welding High Tensile Steels", guides buyers and users of low-alloy, low-hydrogen electrodes. *Arcos Corp.*

668. Welding Electrodes

16-page brochure, Bulletin AR51-1, "Alloy Welding Electrodes for Defense Production", describes electrodes for armor, high-temperature alloys, high strength steels and special applications. *Alloy Rods Co.*

669. Welding Equipment

Welder's crayons for permanent markings on metal surfaces are described in folder. *Wm. Korn, Inc.*

670. Welding Equipment

Cadweld process and complete list of arc-welding accessories are described in catalog. *Erico Products, Inc.*

671. Welding Equipment

New apparatus catalog, 20-C, presents complete information on company's line of welding equipment. *Victor Equipment Co.*

672. Welding Rods

Guide to use and selection of electric arc rods and gas rods and fluxes. *Permalastem Welding Alloys, Inc.*

673. Welding Torch

Information available on HW-8 pistol-grip torch which needs no forging pressure, works from one side of the sheet and spot welds both stainless and carbon steels. *Linde Air Products Co.*

[• If mailed from countries outside the United States, proper amount of postage stamps must be affixed for returning card]

March, 1952

390	422	454	486	518	550	582	614	646	
391	423	455	487	519	551	583	615	647	
392	424	456	488	520	552	584	616	648	
393	425	457	489	521	553	585	617	649	
394	426	458	490	522	554	586	618	650	
395	427	459	491	523	555	587	619	651	
396	428	460	492	524	556	588	620	652	
397	429	461	493	525	557	589	621	653	
398	430	462	494	526	558	590	622	654	
399	431	463	495	527	559	591	623	655	
400	432	464	496	528	560	592	624	656	
401	433	465	497	529	561	593	625	657	
402	434	466	498	530	562	594	626	658	
403	435	467	499	531	563	595	627	659	
404	436	468	500	532	564	596	628	660	
405	437	469	501	533	565	597	629	661	
406	438	470	502	534	566	598	630	662	
407	439	471	503	535	567	599	631	663	
408	440	472	504	536	568	600	632	664	
409	441	473	505	537	569	601	633	665	
410	442	474	506	538	570	602	634	666	
411	443	475	507	539	571	603	635	667	
412	444	476	508	540	572	604	636	668	
413	445	477	509	541	573	605	637	669	
414	446	478	510	542	574	606	638	670	
415	447	479	511	543	575	607	639	671	
416	448	480	512	544	576	608	640	672	
417	449	481	513	545	577	609	641	673	
418	450	482	514	546	578	610	642		
419	451	483	515	547	579	611	643		
420	452	484	516	548	580	612	644		
421	453	485	517	549	581	613	645		

METAL PROGRESS,

7301 Euclid Avenue, Cleveland 3, Ohio

Please have literature circled at the left sent to me.

Name

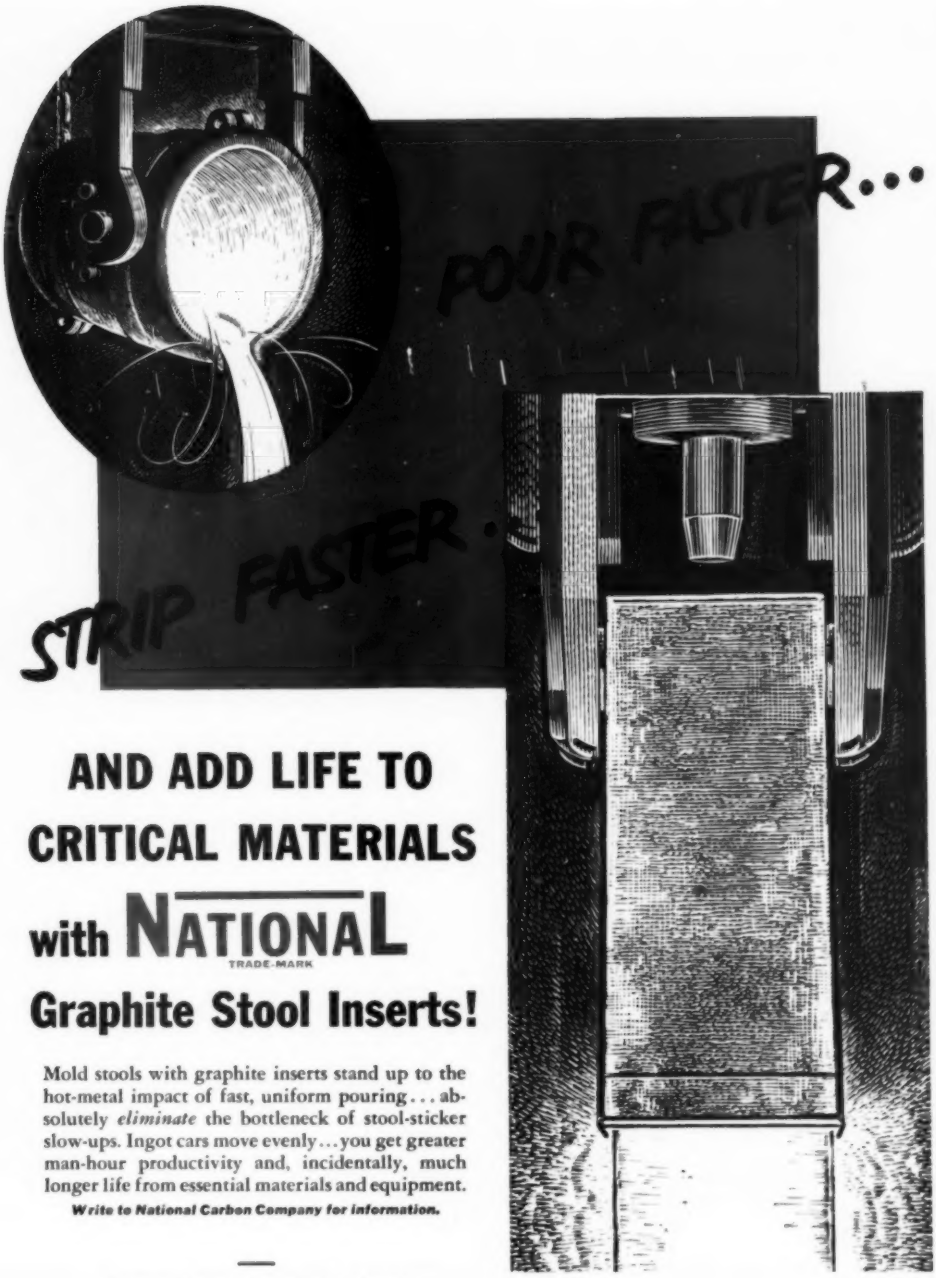
Title

Company

Address

City and State

Postcard must be mailed prior to June 1, 1952— Students should write direct to manufacturers.



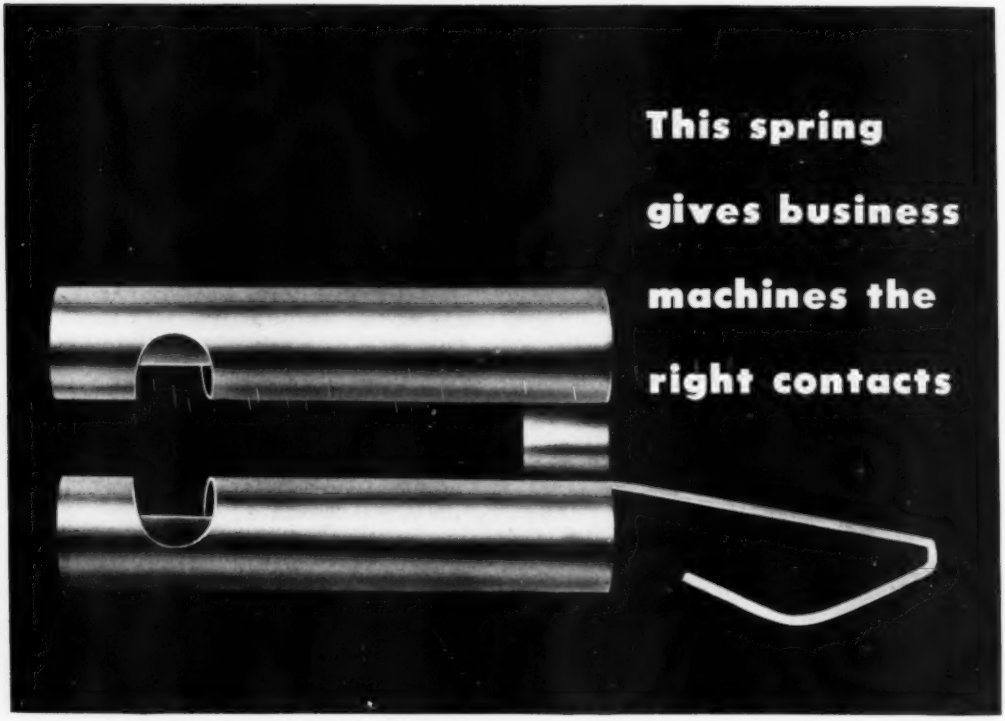
AND ADD LIFE TO CRITICAL MATERIALS with NATIONAL TRADE-MARK Graphite Stool Inserts!

Mold stools with graphite inserts stand up to the hot-metal impact of fast, uniform pouring... absolutely *eliminate* the bottleneck of stool-sticker slow-ups. Ingot cars move evenly... you get greater man-hour productivity and, incidentally, much longer life from essential materials and equipment.

Write to National Carbon Company for information.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: National Carbon Limited, Montreal, Toronto, Winnipeg



IT'S MADE OF BERYLCO BERYLLIUM COPPER

IBM accounting machines sort information, read it, count it, remember it, print it—automatically. The terminal spring shown here serves as a breakable contact between internal circuits and counter units. Naturally the electrical and mechanical requirements of this component must be exacting if the machine is to function perfectly. That's why Berylco beryllium copper was chosen to play a vital, though inconspicuous, role in its operation.

No other material provides the versatility demanded by this design. Conflicting requirements include good spring properties to maintain positive contact and excellent ductility to withstand severe forming both during fabrication and assembly. Among the other properties essential to this application are good resistance to corrosion and repeated stress, high electrical conductivity, low contact resistance and close tolerances.

To find out what Berylco can do for you, take advantage of the know-how of the world's largest producer. Write or phone any of the offices listed below.

The full story of the use of Berylco in IBM accounting machines is given in the interesting booklet "Beryllium Copper at Critical Points." Send for your free copy today.

TOMORROW'S PRODUCTS ARE PLANNED TODAY WITH BERYLCO BERYLLIUM COPPER

Sample material available for testing purposes

BERYLCO THE **BERYLLIUM** CORPORATION

DEPT. 2C, READING 9, PENNSYLVANIA

New York • Springfield, Mass. • Cleveland • Dayton • Detroit • Chicago • Minneapolis • St. Louis • Seattle • San Francisco • Los Angeles

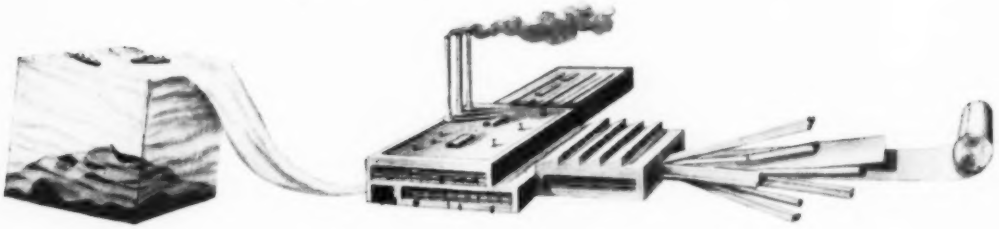
Representatives in principal world-trade centers

MAGNESIUM

and the

problem of

METAL SUPPLY



for your product

The problem of metal supply is in reality a dual problem. First is the question of raw material supply and second, the supply of fabricated forms. To each of these, magnesium offers an interesting answer.

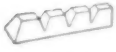
As the increased demands of industry call for more and more metal from Mother Earth, ore reserves become ever more important. Magnesium metal, now extracted from the sea, is the one metal with literally an inexhaustible supply. Consider this fact:

If magnesium were extracted from the sea at the rate of 100 million tons per year . . . the current rate of iron and steel production . . . for 1,000,000 years, we would have reduced the supply in those seas only from 0.13% to 0.12%!

And those seas are at our very shores, eliminating the costs and hazards of transportation. Here is a potential of interest to every metal user.

At the other end of the supply problem is the question of fabricated forms. Currently, Dow is constructing an 84" hot and cold sheet and strip mill, the first in this country for magnesium. When completed, this mill at Madison, Illinois, will increase Dow's capacity for sheet, plate and strip by many times . . . with provision for even further expansion. This new Dow mill will also have facilities for extrusion, increasing present capacity appreciably.

Metal supply? Keep your eye on magnesium . . . the world's lightest structural metal . . . offering you the potential of infinite supply.



For Your Product . . . Tomorrow!

Magnesium's perfect combination of light weight and high strength makes it invaluable to our defense effort. "Drafted" today, it still deserves every consideration in planning for your tomorrow's product. Wherever a product is made to be moved or lifted, magnesium is a must. 75% lighter than iron, 30% lighter than aluminum, magnesium is the world's lightest structural metal.

Magnesium Division

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Atlanta • Cleveland • Detroit • Chicago • St. Louis
Houston • San Francisco • Los Angeles • Seattle • Dow Chemical of Canada, Limited, Toronto, Canada

ONE JUMP AHEAD

The superior quality and purity of

NIALK® *TRICHLORethylene*

for metal-cleaning and degreasing results from Niagara's determination to produce electro-chemicals that are uniformly better.

NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, N. Y.

Liquid Chlorine • Caustic Potash • Carbonate of Potash • Paradichlorobenzene • Caustic Soda
TRICHLORethylene • NIAGATHAL® (Tetrachloro Phthalic Anhydride)

For Top Production:

IN-LINE X-RAY INSPECTION

For mass inspection of parts, the Westinghouse Productograph offers safe, speedy X-ray examination—easily fits into production lines. Fully ray-proofed, the Productograph requires no specially trained X-ray operator—can be pre-set for mass inspections, or manually controlled for individual checks.

This unit can be used with Westinghouse 150 kv or 250 kv industrial X-ray units. Two 14" x 17" parts trays are carried on dollies through the unit to permit a maximum number of inspections per exposure.

For highest speed in mass X-ray inspections, select the Productograph. Call your Westinghouse representative, or write: Westinghouse Electric Corporation, Dept. P-61, 2519 Wilkens Avenue, Baltimore 3, Maryland.

YOU CAN BE SURE...IF IT'S

Westinghouse

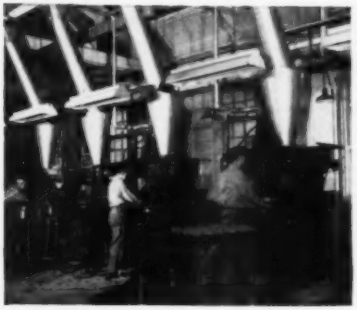
INDUSTRIAL X-RAY

ALCOA -your first source for ALUMINUM CASTINGS

- Four modern foundries, two die casting plants—strategically located from coast to coast.
- Castings made by all 4 production processes—sand, plaster, permanent mold and die.
- 41 years in the casting business, 30 years in the die casting business, 64 years of aluminum experience.
- Design and development help backed by the world's greatest aluminum research facilities.

"SEE IT NOW," with Edward R. Murrow, brings the world to your armchair...CBS-TV every Sunday--3:30 P.M. EST

Facilities like these mean satisfaction with your source of supply—

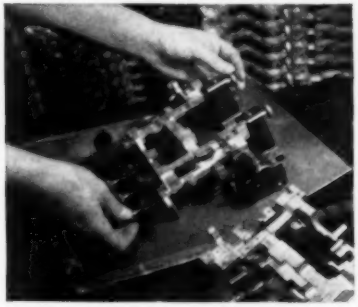


CORE MAKING—fast, high quality production of cores is assured by Alcoa's modern sand handling equipment and large capacity core ovens.

POURING TEMPERATURES—are constantly checked and recorded at control stations on all foundry floors. Procedure like this and continuous alloy control guarantee highest quality aluminum castings and die castings.

HIGH PRODUCTION CAPACITY—of Alcoa's die casting plants is partially represented in this row of cold chamber machines at Alcoa's Chicago die casting plant.

PERMANENT MOLD CASTING—formerly considered for small parts only. Today permanent mold castings weighing up to 500 pounds are not unusual.



INSPECTION—of every part is standard practice in Alcoa plants. Dimensional checks, as shown here, or visual inspection by trained personnel reduces costly rejects. Metallurgical checks further guard the castings' quality.

FINISHING—many secondary machining operations are performed by Alcoa foundries and die casting plants. Machining, grinding, sand blasting, and ball burnishing are but a few.

Ask **ALCOA** *first whatever your need in Aluminum*

While the sale of our products is presently controlled by government regulations, you'll find no limitations on help in design, application or fabrication. Your local Alcoa sales engineer and your local Alcoa distributor are headquarters for "everything" in aluminum. They will cooperate to the fullest in helping you get the metal you need. They are listed under "aluminum" in your classified phone book.

ALUMINUM COMPANY OF AMERICA
1914C Gulf Building, Pittsburgh 19, Pa.

SHEET, PLATE, FOIL

TUBE, PIPE AND PIPE FITTINGS

ELECTRICAL CONDUCTOR

EXTRUSIONS AND ROLLED SHAPES

CASTINGS AND FORGINGS

FASTENERS AND SCREW MACHINE SPECIALTIES

PAINT PIGMENTS, FLUXES AND LUBRICANTS

WIRE, ROD AND BAR

ALCOA *first in* ALUMINUM

ALUMINUM COMPANY OF AMERICA

ALCOA ALUMINUM

This door is always open

The purchase of a new tool is not in itself assurance of greater profit. Equally important is its proper application to the job.

Our plant has become the forging laboratory, our engineering department the forging encyclopedia and our organization the forging consultants for industry.

Our leadership as pioneers of forging methods and applications establishes our ability to help you best.

When you come to NATIONAL, this service is yours.

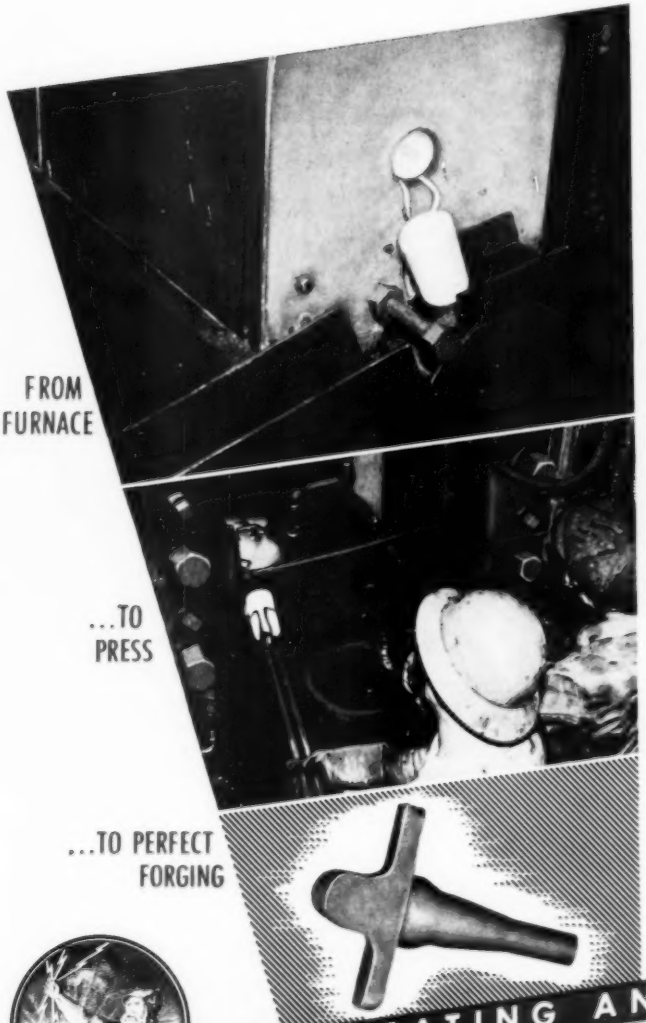
NATIONAL
MACHINERY COMPANY
TIFFIN, OHIO—SINCE 1874

DESIGNERS AND BUILDERS OF MODERN FORGING MACHINES • MAXIPRESSES • REDUCEROLLS • COLD HEADERS • BOLTMAKERS • NUT FORMERS • TAPPERS • NAILMAKERS

Hartford Detroit Chicago

Saves ten tons of steel a day–

WITH AJAX-NORTHRUP INDUCTION HEAT



Improved forging methods, using Ajax-Northrup induction heat, have reduced billet weights for these axle spindle forgings from 7½ to 5¼ pounds. Resultant steel savings add up to *ten tons* of SAE 5132 bar stock a day!

Up to 720 scale-free billets per hour are fed directly from an Ajax-Northrup heater to 1750-ton Maxipress extrusion presses. Forgings are formed in one operation, saving time and labor, and reducing floor-space and equipment requirements.

Ajax-Northrup heat saves up to 20% of original billet weight. First, by elimination of scale, and second, by accurately controlled, even, penetrating heat which permits forging to extremely close tolerances . . . 2 ounces for an 8-lb. connecting rod, to quote another example.

Better heat means better fiber flow, too. As a result, fatigue resistance of the axle spindles is reported to be 17.3% better than that of conventionally heated, hammered forgings.

Ajax-Northrup can save steel, time, and labor in your plant, too. Write us today . . . call on our 35 years of induction heating and melting experience.

SEND FOR NEW INDUCTION HEATING AND MELTING BULLETIN

136

FOR HEATING AND MELTING

AJAX

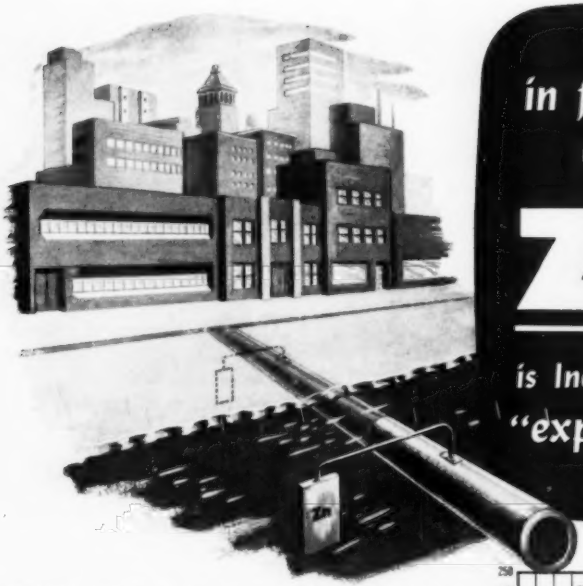
Associate Companies

AJAX ELECTRO METALLURGICAL CORP.
AJAX ELECTRIC FURNACE CORPORATION
AJAX ELECTRIC COMPANY, INC.
AJAX ENGINEERING CORPORATION

AJAX NORTHRUP

AJAX ELECTROTHERMIC CORPORATION

AJAX PARK
TRENTON 5, NEW JERSEY



in fighting corrosion with corrosion—

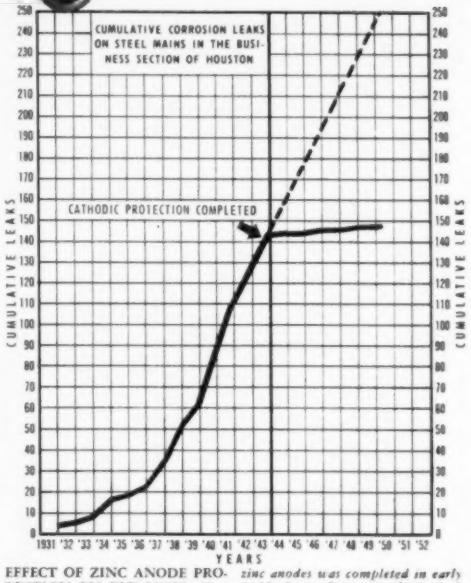
ZINC

is Industry's most effective "expendable" weapon!

NEARLY 50% of all the zinc consumed annually in the United States – around 400,000 tons – is used in galvanizing, i.e., protective zinc coating on iron or steel. This is ample evidence of the firmly established position of the metal as industry's most effective and economical "sacrificial" weapon in its unceasing combat with rust. The electrochemical reaction between iron and zinc, which has resulted in the dominance of zinc in this field, is precisely the same as that which takes place in the relatively new and growing use of the metal for cathodic protection of pipe lines and other underground iron and steel structures. The sole difference between the two methods being that in cathodic protection the zinc, in the form of anodes, is buried adjacent to a pipe line and connected by a conductor, while in galvanizing the zinc is bonded to iron or steel. In either form, zinc "protects" – as has been attested to by those progressive companies who have used zinc anodes for this purpose. For example, in the Northwest, a utility company reports:

"The most interesting installation was made in 1942 on four inch bare pipe located in the seepage from an irrigation ditch that circled the brow of a hill in such a manner that the pipeline trench intersecting the irrigation ditch was kept moist throughout the season. Approximately seven hundred feet of this four inch line had been replaced twice. In the spring of 1942 leakage developed and when the pipe was uncovered it was found to be in bad condition. Pending replacement, repairs were made and seventeen zinc anodes were installed with series-parallel connections. In the press of other work, this replacement job was put aside and in 1943 it was found that no further leaks had developed. In 1948 the replacement had still not been made and we were getting a good potential-to-ground and plenty of protective current. The last test made in the spring of 1950 shows a slight increase in the potential-to-ground and the pipe has not been replaced nor have we felt it even necessary to uncover it for visual inspection."

The graph at right provides additional evidence from the State of Texas. Here are two examples, under widely dissimilar conditions, where zinc has proved itself as a highly efficient cathodic protector for underground pipe lines. This is not surprising in view of the long-recognized superiority of the metal in the field of galvanizing.


CUMULATIVE CORROSION LEAKS ON STEEL MAINS IN THE BUSINESS SECTION OF HOUSTON
CATHODIC PROTECTION COMPLETED
CUMULATIVE LEAKS
CUMULATIVE LEAKS
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
1931 '32 '33 '34 '35 '36 '37 '38 '39 '40 '41 '42 '43 '44 '45 '46 '47 '48 '49 '50 '51 '52
YEARS

EFFECT OF ZINC ANODE PROTECTION ON OLD LINES. *Most of the United Gas Corp.'s welded-steel-gas distribution mains, coated with hot asphalt and asbestos wrapper, were installed before 1930. Cathodic protection of mains with zinc anodes was completed in early 1944. Curve shows cumulative leak record of these mains. Only 5 corrosion leaks occurred in the 6 years since cathodic protection was applied, comparing with 142 during 1932-1944.*

ST. JOSEPH LEAD COMPANY 250 PARK AVE., N.Y. 17

for Galvanic & Cathodic Protection Zinc is Standard

Zn

ST. JOE Electro-Thermic ZINC: *High grade, Intermediate, Brass special, Prime western*

BUNKER HILL 99.99+% ZINC

NEW Streamlined AB SPEED PRESS

The most advanced design in press equipment for speed, convenience, and economy in the production of Bakelite and Transparent Molded Specimen Mounts ever presented to the metallurgist.

A revolutionary feature introduced in this new press is preheated Premolds. The preheat compartment reduces the curing time of thermo-setting molds to one-third of the time usually required. It enables the operator to produce perfect Bakelite Mounts in 2½ to 3½ minutes. All necessary indicators and controls including pressure gauge, pyrometer, thermostats, timer and pilot lights are provided. No experience is required to produce perfect mounts. Automatic ram retraction saves time and effort.

The hinged press head is made with a semi-automatic lock and a hand wheel screw to close the mold securely. Heating blocks are arranged with a magnetic closure to snugly envelop the mold assembly. The interchange of thermostatically controlled heating units of 600 watt capacity is facilitated by convenient supports. Cooling blocks are located in a practical position in front of the press cabinet.

This new speed press is the result of long exacting experiment, with every effort devoted to designing the finest modern specimen press we are able to engineer.

No. 1330 AB Speed Press, complete for 1" mountings $420.00

No. 1330-2 AB Speed Press, complete for 1¼" mountings $440.00

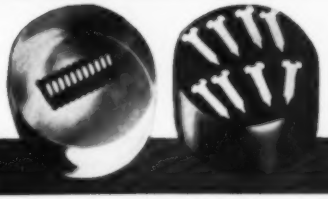
No. 1330-3 AB Speed Press, complete for 1½" mountings $460.00

THE BUEHLER LINE OF SPECIMEN PREPARATION EQUIPMENT INCLUDES . . . CUT-OFF MACHINES • SPECIMEN MOUNT PRESSES • POWER GRINDERS • DISC GRINDERS • HAND GRINDERS • BELT SURFACERS • MECHANICAL AND ELECTRO POLISHERS • POLISHING CLOTHS • POLISHING ABRASIVES.

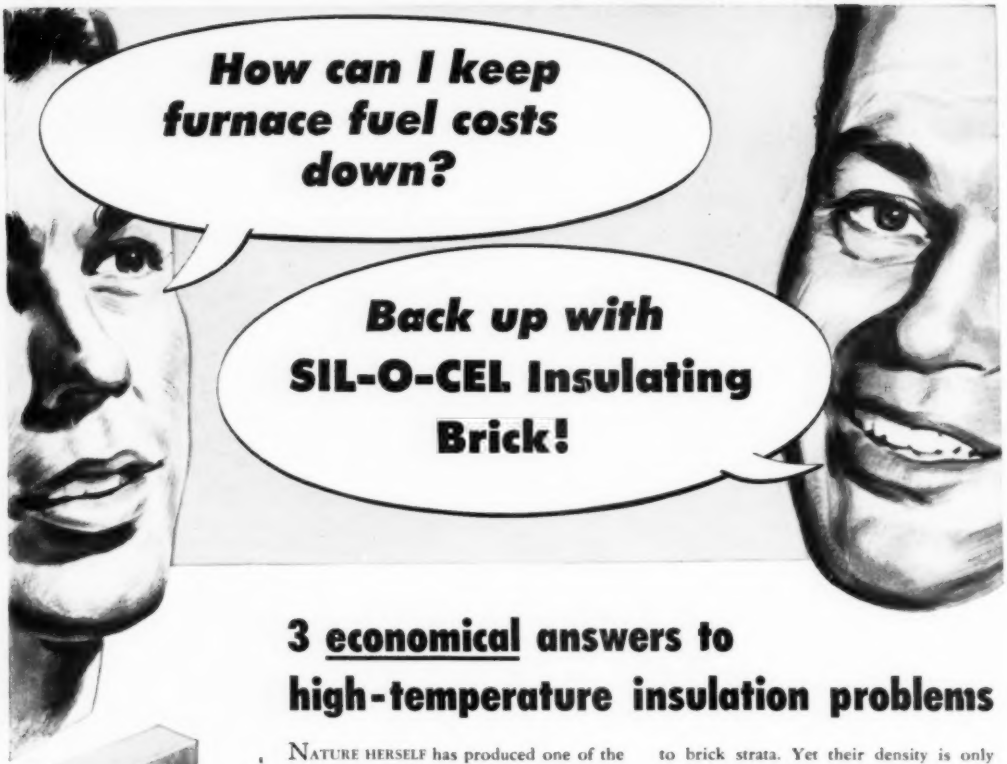
Buehler Ltd.

A PARTNERSHIP

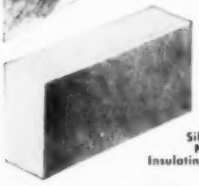
165 WEST WACKER DRIVE CHICAGO 1, ILLINOIS

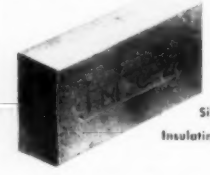


METALLURGICAL APPARATUS



3 economical answers to high-temperature insulation problems


Sil-O-Cel Natural Insulating Brick


Sil-O-Cel C-22 Insulating Brick

Sil-O-Cel Super Insulating Brick

NATURE HERSELF has produced one of the most effective high-temperature insulating materials ever discovered—diatomaceous silica, from which Sil-O-Cel® Insulating Brick are made.

These insulating brick are used for back-up insulation behind fire brick or insulating fire brick linings in boilers, stills, stacks, heat-treating furnaces, kilns, lehrs, flues, retorts, and other types of high-temperature equipment.

Sil-O-Cel Insulating Brick have excellent insulating qualities combined with high load-bearing characteristics and light weight.

Made in all standard shapes of the 2½ in. and 3 in. series, Sil-O-Cel Insulating Brick are produced in three basic types:

SIL-O-CEL NATURAL INSULATING BRICK
for temperatures to 1600F

Quarried directly from one of the world's purest deposits of diatomaceous silica, these insulating brick have a conductivity of only 0.79 Btu in./sq ft/F/hr at 1000F mean temperature, with heat flow perpendicular to brick strata. Yet their density is only 30 lb/cu ft. Cold crushing strength, 400 psi.

SIL-O-CEL C-22 INSULATING BRICK
for temperatures to 2000F

Ideal where high load-bearing properties are needed, this type of Sil-O-Cel is calcined, and has a cold crushing strength of 700 psi. Conductivity is 1.88 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 38 lb/cu ft.

SIL-O-CEL SUPER INSULATING BRICK
for temperatures to 2500F

A calcined insulating brick for unusually high temperatures. In many cases, it is also possible to save on construction costs by reducing the thickness of fire brick or insulating fire brick when backed with Sil-O-Cel Super Insulating Brick. Conductivity is 1.95 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 40 lb./cu. ft. Cold crushing strength, 300 psi.

For further information, write to Johns-Manville, Box 290, New York, N. Y. In Canada, write 199 Bay St., Toronto 1, Ont.

JOHNS MANVILLE JM PRODUCTS **Johns-Manville** *first in* **INSULATIONS**

ONE Nichrome*

"One World." All over the globe, men have come to acknowledge this unique concept as the most effective basis for solving innumerable problems related to human progress.

"One Nichrome." All over the globe, men have come to acknowledge this unique alloy as the most effective means for solving a host of problems also related to human progress—in the fields of engineering and production.

This being so, we take particular pride in our trademark: NICHROME—granted solely and wholly to us by the United States Patent Office forty-three years ago. Representing a series of superb electrical heating and resistance alloys, developed and produced *only* by Driver-Harris, it symbolizes top quality and utmost dependability to manufacturers everywhere.

*T. M. Registered in United States Patent Office by Driver-Harris Company August, 1908

World-Famous **Nichrome**® is produced only by

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

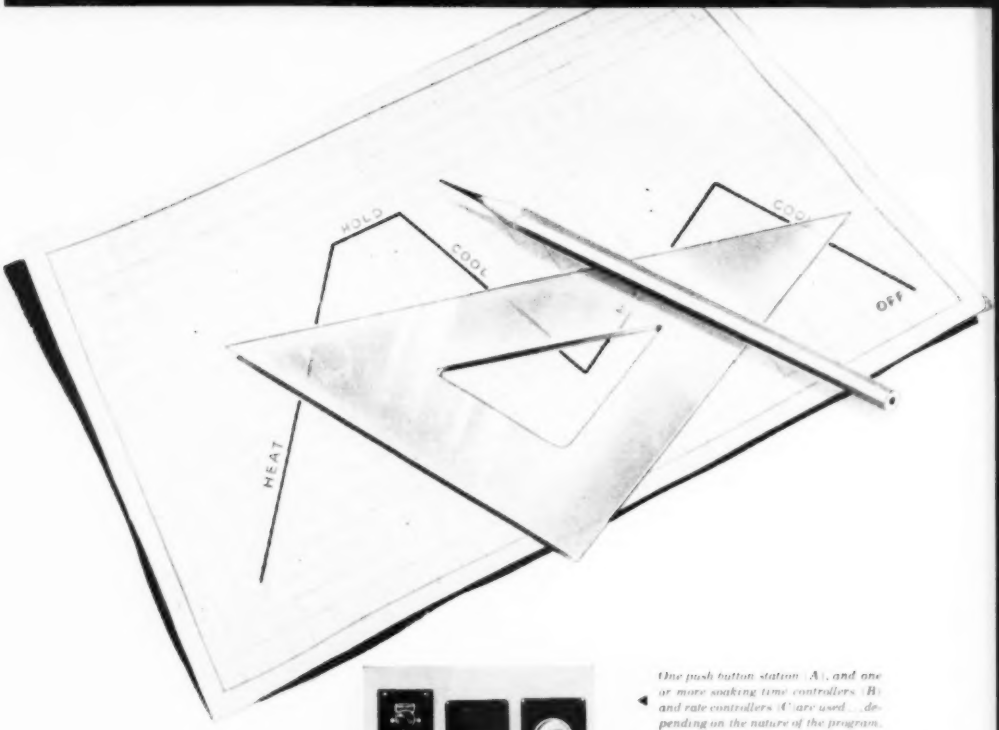
Manufactured and sold in Canada by The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

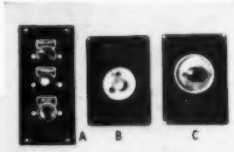
Factories: U. S. A., CANADA, ENGLAND, IRELAND, FRANCE, ITALY, SPAIN Representatives in 38 COUNTRIES

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

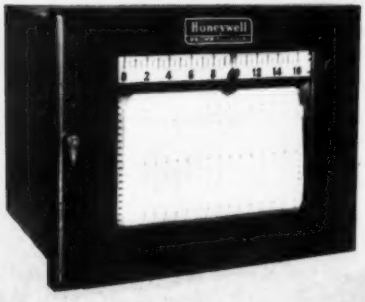
Plan Time *vs*

any way you like . . . with NEW





One push button station (A), and one or more soaking time controllers (B) and rate controllers (C) are used . . . depending on the nature of the program.



BROWN PROGRAM CONTROLLER WITH MOTOR DRIVEN INDEX

. . . the peak in flexibility, providing an infinite variety of programs. Heating or cooling rates are calibrated in degrees hour, soaking time in hours or minutes . . . both are easily set. Three front-of-instrument temperature settings are available at which heating rate can change or soaking begin. Automatic change from heating to artificial cooling can be provided. Multi-zone control is also available.

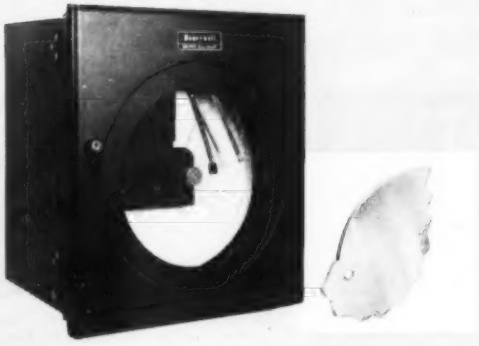
Temperature

ElectroniK Program Control

Now, *ElectroniK* Program Controllers offer you a free hand in securing automatic regulation of time-temperature cycles. The way these controllers conduct furnaces through complete heating, cooling and soaking periods . . . signalling operators when critical points are reached . . . shutting off equipment at the end of the cycle . . . makes them exceed human abilities.

ElectroniK Program Controllers are designed for complete systems. Available with all varieties of electric and pneumatic control forms (including time or position-proportioning control). For a discussion of how this new, advanced control can improve your production, call in our local engineering representative . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4503 Wayne Ave., Philadelphia 44, Pa.



BROWN CAM-OPERATED PROGRAM CONTROLLER

. . . for frequently repeated cycles. Cam is easily cut to desired time-pattern on calibrated disc of clear plastic. Nonlinear rise or fall is readily produced. Any number of heating, cooling and holding periods can be incorporated. Entire program is readily apparent, and can be duplicated at any time. Program change requires only the replacement of the cam.

Plastic cams are easily cut to any desired pattern.

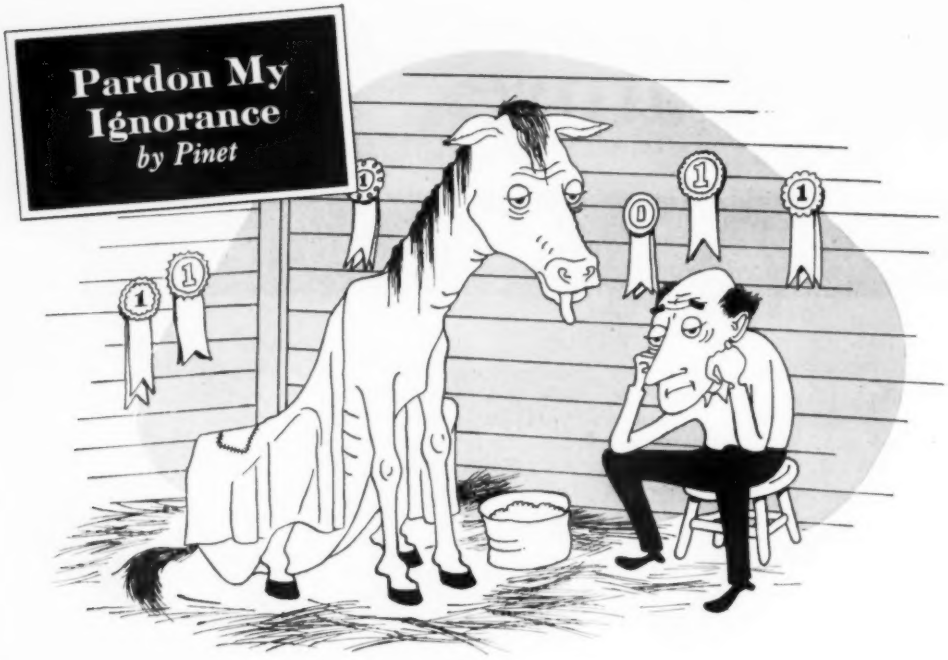
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

● *Important Reference Data*

WRITE FOR LITERATURE ON BROWN PROGRAM CONTROLLER WITH MOTOR DRIVEN INDEX AND ON BROWN CAM-OPERATED PROGRAM CONTROLLER



I thought STABILIZED ZIRCONIA was a run-down race horse ... until I got the facts from Norton

Now I Know:

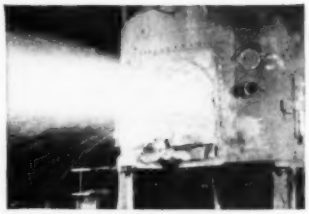
Stabilized Zirconia is the latest and most sensational answer to the demand for refractories that will resist higher and higher temperatures.

Norton *Fused Stabilized Zirconia* crucibles and cement linings are unaffected by operating temperatures up to 4200 F in high frequency induction furnaces. What's more, Zirconia cement linings *are not wet* by many of the metals melted in this type furnace.

By adding *Fused Stabilized Zirconia* to its already well-known ALUNDUM*, CRYSTOLON*, and MAGNORITE refractory cements and shapes, Norton Company is better equipped than ever to engineer special refractories to fit your *exact* requirements.

Why be satisfied with refractories that are just good enough, when you may be able to improve your processes and reduce your operating costs with Norton special refractories? Explain your metal-melting problem to your nearby Norton representative — or write direct to Norton Company, Refractories Division, 320 New Bond St., Worcester 6, Mass. Canadian representative: A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

IN HIGH FREQUENCY INDUCTION FURNACES, particularly for melting platinum and its alloys, Norton FUSED STABILIZED ZIRCONIA crucibles can't be beat. Since they are not wetted by metal, you recover 100% of the melt without destroying the crucible. You can also use the same furnace for different alloys without contamination.



IN BACK-SLAGGING CUPOLAS, slag hole blocks made of Norton CRYSTOLON silicon carbide refractory let you complete your campaigns without stopping for replacement. No softening nor spalling at temperatures up to 3050 F. They resist corrosion, erosion and slag penetration many times longer than fireclay block. Try them and see.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON

Special REFRACTORIES

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

Metal Progress

Vol. 61, No. 3 • March 1952

Copyright, 1952, by American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio. Published monthly; subscription $7.50 a year in U.S. and Canada; foreign $10.50. Single copies $1.50; special issues $2.00. Entered as second-class matter, Feb. 7, 1921, at the post office at Cleveland, under the Act of March 3, 1879 . . . The American Society for Metals is not responsible for statements or opinions printed in this publication . . . Requests for change in address should include *old* address of the subscriber; missing numbers due to "change in address" cannot be replaced. Claims for nondelivered copies must be made within 60 days.

Ernest E. Thum, *Editor* Marjorie R. Hyslop, *Managing Editor* John Parina, Jr., *Associate Editor*

Floyd E. Craig, *Art Director*

Cover design by Roland Jelarcic

The Atomic Age

Power From the Atom 70

Technical Articles

How Can We Appraise Metals for High-Temperature Service?
by Thomas J. Dolan 55

White Brass Plating—One Solution to the Nickel Freeze
by Webster B. Knight 61

The Impending Revolution in Casting Processes
by H. H. Harris 65

Liquid Sodium—a Noncorrosive Coolant
by R. F. Koenig and S. B. Vandenberg . . 71

An Unusual Tin Bronze Casting
by Harold J. Roast 76

Trends in Corrosion Control
by H. H. Uhlig 82

Critical Points

Light Metals Cast in Gypsum-Sand Molds . . . . Better Lubrication of Cutting Tools . . . . Have You Something Hard to Grind or Hot to Handle? . . . . Steel (Yes, Steel) With 0.45% Sulphur 51

Correspondence

Selling Research to Management
by Perry B. Cassidy 78

Welded Monoframes
by H. E. Cable 79

Course of Impact Fracture
by L. H. Satz 79

Perchloric Acid Hazard
by E. Knuth-Winterfeldt 80

Turbine Blades "Sweat Cooled"
by George Atwell Richardson 81

Polishing Tantalum
by G. W. Wensch, K. B. Bruckart and M. Conolly 81

Departments

Data Sheet: Typical Properties of Beryllium-Copper Alloys
Prepared by J. T. Richards 80-B

Personals 90

Engineering Digest of New Products . . 17

Manufacturers' Literature 23

Advertisers' Index 184

Abstracts of Important Articles

Defects in Rolled Products 98
By Paul Grüner and T. Brüggeman, Report No. 193 of the Subcommittee on Rolling, Verein Deutscher Eisenhüttenleute.

Factors Influencing Structure of Electrodeposits 106
By J. J. Dale, a paper presented before the Australian Institute of Metals, Physical Metallurgy Division, 1949, as part of the Symposium on Electrodeposited Metals.

Effect of Hydrogen on Low-Alloy Steels . . 114
By J. D. Hobson and C. Sykes, *Journal*, British Iron and Steel Institute, Vol. 169, November 1951, p. 209.

Chromium Impregnation of Carbon Steel . 118
By T. P. Hoar and E. A. G. Croom, *Journal*, British Iron and Steel Institute, Vol. 169, October 1951, p. 101.

Resin Binders for Foundry Sand 126
By P. G. Pentz, *Metal Industry*, June 22, 1951, p. 504.

New Super-Alloys 127
By R. H. Thielemann, J. C. Mertz and W. P. Eddy, Jr.; paper for S.A.E. 1952 annual meeting.

Direct Reduction of Iron Ore 147
By M. Tenenbaum and C. M. Squarcy, American Iron & Steel Institute Yearbook, 1951, p. 208.

Stains on Aluminum-Sprayed Steel Surfaces 150
By W. E. Ballard, *Electroplating & Metal Spraying*, Vol. 4, December 1951, p. 395.

Creep Properties of Austenitic Alloys . . 156
By A. M. Borzdyka, *Doklady Akademii Nauk S.S.S.R.*, Vol. 75, 1950, p. 37.

Do you Recognize the Steel Parts Pictured Below?

They represent 9 reasons why you may still have trouble getting Inland Steel

In spite of Inland's record-shattering production year (12 all-time records were broken in 1951), Uncle Sam allocated much of the steel you needed to the Armed Services. That's why Inland is adding capacity to give you the steel you need.

1. Section of aircraft landing mat
2. Ration cans
3. Frame for army cot
4. Aviation gas truck tank
5. 105 mm. howitzer gun tube
6. Barbed wire entanglement post
7. 5 gallon "Blitz" can for gas or water
8. Forging for 105 mm. shell
9. Fin assembly for 500 lb. cluster bomb

INLAND

INLAND STEEL COMPANY

38 South Dearborn Street • Chicago 3, Illinois

Critical Points

BY THE EDITORS

Light Metals Cast in Gypsum-Sand Molds

TWENTY-TWO YEARS ago Pres. Arthur Morgan gave $300 to a senior physics student at Antioch College (the "cooperative" institution where students alternate on ten-week intervals between jobs and study) for a scientific look at operations in a tiny foundry the college had established at Yellow Springs for making art bronzes by the lost-wax process. This foundry was manned by one Italian and one French artisan, and their traditional techniques were sometimes at variance, which not only interfered with production (if any) but with the peace of the rural community. In his laboratory the student, Morris Bean, "cast a lot of beautiful bronze butterflies", as he said, using vacuum techniques, but was bitten by a more contagious bug, the desire to get sound metal into thin sections by some less esoteric means — if possible with the use of a fluid mold material which seemed so much handier than moist sand, material that could be poured into the flask around the pattern, yet eventually have the necessary porosity for venting gas from mold or metal.

Eventually he hit upon the sand-gypsum-water mixture which is now the basis of the unique aluminum foundry of Morris Bean & Co., a plant and operation as modern as tomorrow, set in rural surroundings as charming as lavender and old lace. An overhead traveler carries the mold ingredients, mixes them only as required, and spouts them into flasks or core boxes on benches, right or left. Patterns are of metal, very precise, and carefully oiled. The slurry is half sand (No. 50 on the American Foundrymen's scale), half commercial plaster of paris, and contains about one part of water for two parts of dry ingredients. It has the consistency of cream soup; the molder, with fingers and brush, makes sure there are no air bubbles or water breaks in thin ribs on the pattern or around reinforcements — quickly, for within 6 min. the plaster has set and the pattern can be drawn. At this stage the mold can be blown out, minor repairs made, inspected and handled with impunity, yet it may contain ribs ⅛ in. thick, 1 in. high, and with zero draft. (Thin ribs are usually reinforced; paper clips do for short ones, strips of wire screen for long ones.)

In the action of setting, the plaster of paris, $2CaSO_4 \cdot H_2O$, absorbs water and converts itself into $CaSO_4 \cdot 2H_2O$. In this condition the permeability of the bonded sand is practically zero. The next step is to recrystallize this calcium sulphate into a skeleton of larger interlocked crystals with the necessary air spaces between. First it is necessary to reconvert much of the $CaSO_4 \cdot 2H_2O$ into a water solution and this takes 9 hr. in an autoclave with superheated steam at 15 psi. gage. The thoroughly heated molds are then stacked in the open air and cool so slowly that recrystallization starts at relatively few centers. In 12 hr. the entire quantity of gypsum has reconverted itself into sizable interlocking crystals of $CaSO_4 \cdot 2H_2O$ which adequately bond the sand. Permeability can vary from 20 to 100 (A.F.S. scale) and is controlled by composition of the original slurry. Final drying is at 450° F. for 3 to 15 hr., depending on size. Since the surface, during recrystallization, dries fairly rapidly, the sulphate crystals there are quite fine, which is all to the good because mold surfaces are then very smooth and have a distinctly soapy feel.

Prime advantages of this method of molding are *(a)* accuracy, since metal patterns are reproduced faithfully and mold dimensions do not change while curing; *(b)* easy and accurate placement of chills, cores, gates and risers; *(c)* uniformity and controllability of mold structure. One disadvantage is that gypsum may get into the melting pot, but Morris Bean is convinced that cleanliness is as much the basis of good castings as of good food, so there is small chance of a dirty riser being melted in his foundry.

Screen gates are always used, to prevent turbulent flow and mold scour by hot metal, and entrance of dross. Each heat is properly degassed; before any mold is poured, the temperature (by pyrometer) must be ap-

proved. A standard plate is cast from each melt and X-rayed; if there is any sign of porosity, each casting of that heat is radiographed, whether specified by the customer or not.

Since the work being made at Morris Bean & Co. is the hard-to-make that other foundries do not like, each new job is carefully engineered, complete drawings made, and molding, chilling, gating, pouring and heat treating practice is perfected by the laboratory before production starts in the main foundry.

Present work on radar parts, torpedo propellers and supercharger compressors is a long way from butterflies in a physics laboratory — a 22-year history which can only be sketched. After a few years of precarious existence as a small art foundry, the Bean organization was asked by Goodyear Tire & Rubber Co. to try to cast tire molds. (Tire molds at that time were engraved from steel at a cost of about $600 each.) The gypsum-bonded mold, made in segments, assembled in a jig and cast in aluminum, was the result, satisfying as to performance and especially as to cost. Word got around, and in 1940 when Allison got its first big order for aircraft engines, General Motors turned Bean's organization loose on cylinder heads. Three years of intensive work by 15 engineers and scientists, 35 technical assistants, and 150 foundry workers were expended, but this was a small price to pay for the results achieved. At the start, cylinder head castings were costing Allison $1.65 per lb. and their quality was such that the engine could develop no more than 1000 hp. Three years later the experimental foundry was making heads of the same weight for 1500-hp. engines at $1.00 per lb. Commercial foundries, said Mr. Bean, "faced with visual evidence that 'the impossible' could be done, not once but continually, fell to, tightened up their own practices, and made thousands upon thousands of cylinder heads cheaper than our small foundry could, and of even better quality."

One source of trouble uncovered during the study of Allison cylinder heads was caused by steam pockets during water quenching after solution treatment. Variable cooling rates locked up high internal stresses; there were some quench cracks; more often the stress distribution was entirely wrong to endure the alternating stresses of operation. Such castings had disappointingly short life even though they were perfectly sound, radiographically. If a light-alloy part must meet a high endurance requirement, the quenching techniques are now selected with the idea of controlling residual stresses. If necessary, prototypes are checked, first with Stresscoat to locate danger spots, then in service with SR-4 strain gages.

Better Lubrication of Cutting Tools

AN INTERESTING VARIANT in metal cutting was seen recently at Gulf Research and Development Co. in Pittsburgh. This observer is among those who have not doubted the need to lubricate or cool the cutting tool, but he has questioned the methods being used. Not only is the conventional practice of flooding the tool inefficient, since only a very small amount of the lubricant reaches the cutting edge, but a large quantity slops over to cool the work as well — an undesirable condition which maintains the shear strength of the metal near its original level rather than permitting it to drop as would happen if it remained heated. (This state of affairs has been discussed by Sam Tour in his various reports on hot metal machining. See, for example, *Metal Progress*, June 1951, p. 793.)

When lubricant floods a cutting tool from above, as on a lathe or vertical boring mill, the chip deflects most of the fluid; very little of it reaches the cutting edge. The obvious correction for this condition (but only now brought forth by Gulf's director of engineering, R. J. S. Piggot) is to squirt the lubricant up from *beneath* the tool.

His method, called "Hi-Jet", uses one or more nozzles with a sharp-edged, 0.018-in. orifice, through which a favorite oil of theirs is delivered at 400-psi. pressure. The tiny jets are shot into the working relief angle (a wedge-shaped space between heel of tool and work) and develop a static pressure of 250 to 300 lb. at point of contact, which forces the trapped oil past the cutting edge (which may be exerting momentary pressures on the work up to 50,000 psi.) through the minute irregularities on the surface being cut. The oil that has been vaporized by localized frictional heat may then blow its way further. That an adequate amount of lubricant actually does get by to reduce

the friction at the interface between tool and work is indicated by comparison tests of the two methods of lubrication. With a high-speed jet from below, tool failure occurs away from the cutting edge in a direction toward the shank where lubrication is still deficient — rather than on the nose of the tool, as usually happens when it is cooled by overhead flooding.

Machining tests were observed on A.I.S.I 1020 steel (tests have been run on 3140, 3150, 8742, stainless and Inconel M) cut with high speed toolsteels in a heavy-duty turret lathe. The force on the tool in a tangential direction, the temperature at tool edge, and the feeding force were recorded, and for the same depth of cut, feed and surface speed, the jet method reduced the turning force, temperature and feeding force by 11, 9 and 33% respectively. Life of the high speed tools is said to be increased from six to twelve times over that obtained with overhead cooling; carbide tools last three to five times as long. J. P.

Have You Something Hard to Grind or Hot to Handle?

WHEN THE EDITOR sat down for lunch in Norton Co.'s general offices in Worcester, Mass., with a dozen leading men in the research, business planning, and development departments he was hardly prepared for the most stimulating two hours of his recent life. These men threw out ideas like sparks from one of their grinders. In fact, this largest firm in its field originated 66 years ago in a sparkling idea in the minds of two Swedes in the Worcester pottery owned by Franklin B. Norton. They imagined that emery (a loose abrasive used for an improved sandpaper) could be bonded with clay and made into grindstones. Their invention was patented in 1877 and the early wheels were tested in the machine shops of Worcester Polytechnic Institute. Eight years later Norton sold his rights to seven local men (including one of the patentees and one of the testers). They got a bargain! Their original $20,000 has multiplied astronomically and their descendants are still the owners and top executives of the enterprise.

Emery wheels turned out to be so good that supplies failed of the natural minerals emery and corundum (crystallized Al_2O_3, more or less pure). Fortunately, by the turn of the century an electric furnace had been devised by Ampere Electro-Chemical Co. of N. J. capable of melting the aluminum ore, bauxite — and equally fortunately, the melt crystallized as it cooled. The Norton firm called this artificial abrasive "Alundum", and now makes it in a Canadian plant near Niagara Falls. Somewhat earlier (1893) E. G. Acheson, of artificial graphite fame, discovered how to make loose crystals of silicon carbide by charging sand, coke and sawdust into an electric resistor furnace. This he called "Carborundum" and it was and is the basis of an important competing firm; however, the Acheson patents have expired and Norton's silicon carbide is dubbed "Crystolon".

Since the abrasive wheels had to be fired, and it was observed that they themselves surpassed firebrick in heat resistance, the manufacture of super-refractories was a natural sequence. With passing years other refractory and hard oxides were studied; magnesia MgO ("Magnorite"), synthetic boron carbide B_4C ("Norbide"), and even more recently, zirconia ZrO_2, were commercialized. One can imagine the diverse problems presented by the manufacture of these raw materials and their later fabrication, through variations in purity of the raw materials, crystallinity of the product, grain size distribution of the crushed abrasive, nature of the bond, and firing of the shapes.

It appears that the bond must have a slight chemical or physical union with the abrasive grain at the firing temperature; that the wheel be strong enough to resist centrifugal force at high-speed operation; and that the bond wear away so the abrasive will jut slightly from the surface. The abrasive, in turn, must consist of fragments with sharp points and edges; it must be hard yet fragile enough to fracture so as to form new cutting edges before the old ones dull very much. Finally, these properties must be assembled in best combination for grinding this, that or the other steel, metal or alloy — even wood fiber, or glass or plastic. Oh yes, the size and shape of wheel or brick can be anything!

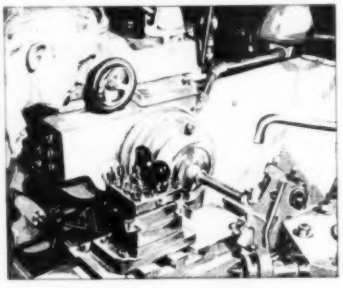
The grain's capacity for splitting before dulling is most important. Wallace Montague, vice-president, said it has only recently been discovered that a dull edge in all likelihood is the result of chemical reaction between

abrasive grain and the material being cut (or physical solution in it). Such troubles are magnified in some laboratory work now being done by Leo Tarasov on the grinding of titanium. All particles of swarf, of course, are quite hot when torn off, and hot titanium has such great chemical activity that it reacts rapidly with any known abrasive grain, dulling it before it fractures. One palliative is to reduce instantaneous temperatures by slowing the wheel down to about one third its normal operating speed. Another might be to have a wheel porous enough to pass a coolant to the grinding surface.

Director of Research Sam Kistler also spoke of recent studies of wear resistant surface plates for toolrooms and gage departments. Surface plates are usually of hard cast iron, which is fine except they wear slightly in use and abrade the bases of gaging equipment. Tests indicate that a plate of fired "Alundum", ground flat and smooth, not only maintains accuracy almost indefinitely, but, surprisingly, does not bite nearly so rapidly into the iron and steel surfaces moved over it. An extension of this idea brought the discovery that iron piston rings practically never wear out if the engine cylinder is lined with a smooth "Alundum" sleeve, and these liners are promising money savers in truck engines which operate in dusty places like open-pit mines, and in slush pumps at oil drill rigs. Impellers and liners of vitrified "Crystolon" are now in commercial use in pumps handling muddy mine water.

Methods of finishing cylinder liners are interesting: They are molded somewhat thick; before final firing they can be machined to a $\frac{1}{4}$-in. wall with a sintered "Alundum" tool; after firing they are ground to finished dimension with diamond wheels — rather an expensive operation.

A lot of study has also been given to Norton products for metal cutting tools. Artificial abrasives are harder than tungsten carbide particles, as measured by Knoop diamond indenter, but unfortunately no suitable binder has been found. Metal doesn't "wet" these abrasives. (Maybe that's why they *are* abrasives.) The sintered "Alundum" tool tip required for cutting the engine or pump liners is molded of fine particles of pure Al_2O_3 and sintered without binder. It is translucent, like rare porcelain. It could be used in a machine shop, for it will cut steel cleanly, although not at high speed, but is probably too fragile for general use.



Steel (Yes, Steel) With 0.45% Sulphur

A NOTEWORTHY CONTRIBUTION to the discussion of free machining steels at conferences of Group No. 1 of the First World Metallurgical Congress in Detroit in October was made by Reginald L. Long, metallurgist for Park Gate Iron & Steel Co., of Sheffield, England, in describing soft steel (less than 0.10% carbon) containing 0.45% sulphur! Sulphur in American standard free cutting steels is seldom pushed above 0.30%, because even at that level end-splitting in the rolling mill is likely to cause trouble — one half of the bar winds around the top roll and the other half around the bottom roll. Mr. Long reported that such troubles almost disappear in his steel, analyzing 0.45% sulphur, 1.4% manganese, less than 0.04% silicon and less than 0.10% carbon. About half of the sulphur is added as iron sulphide in the bath, the rest in the ladle. The material rolls well and has an unusually clean, bright surface while hot and a very light scale when cold.

While we're thinking of sulphurized steel, it might be well to record a topsy-turvy note gleaned from a harassed steelworker: Commercial sulphur is so critically short these days there was none to be bought for manufacturing screw stock. The Editor, harking back to his early experience in a copper smelter, thought of iron pyrites as a substitute. Some of the low-grade copper concentrates are mostly iron sulphide, so valueless it is burned and slagged off. It ought to be a good material for introducing sulphur into steel, and the modicum of copper would improve the corrosion resistance. Maybe, however, the governmental controls on copper are so tight that even this much could not be diverted.

By Thomas J. Dolan, Research Professor of Theoretical and Applied Mechanics
University of Illinois, Urbana

How Can We Appraise Metals for High-Temperature Service?

RECENT YEARS have witnessed a remarkably rapid development of equipment to operate at high temperatures. Many examples are to be found in the fields of chemical processing (including oil cracking processes), in the generation of power, and in new types of engines. Recent advances in jet propulsion, turbosuperchargers, and gas turbines were possible only because new metals were developed to meet the extremely severe requirements of resistance to creep and rupture, fatigue, oxidation, and erosion; in addition, reasonable structural and chemical stability must be maintained if satisfactory service is to be expected.

The principal emphasis in the search for new heat resistant alloys has usually been dictated by the necessity to resist excessive creep at the operating temperature. Many research programs have concentrated on the evaluation of creep rates and the "time-to-rupture" characteristics under constant loads; metallurgical treatments have often been evaluated primarily on the basis of these static load properties. However, the problems encountered in turbine blades and combustion chambers have emphasized the need for more information on the resistance to progressive damage (fatigue) when subjected to repeated loading at elevated temperatures, both with regard to fatigue strength and the influence of fluctuating loads on creep rate.

This paper* and its sequel will summarize the principal observations on the factors influencing the fatigue strength of metals at high temperatures. Most of these experimental studies should be regarded as qualitative only; much analytical and experimental work needs to be done before accurate design procedures can be evolved.

CREEP VERSUS FATIGUE

A great deal has been learned during the past 100 years about the qualitative nature of the many factors affecting fatigue of metal. Even for operation at room temperatures, however, the difficulty of predicting fatigue strength of a particular member is evident from the fact that the following factors all influence it:

1. The material (including its metallurgical condition and method of processing or forming).
2. Alteration of the material by plastic action, aging, precipitation, relaxation, or recrystallization.
3. Environment (presence of corrosive or chemically active media).
4. Geometric shape of the member, and surface finish.
5. Over-all size of the member.
6. Presence of residual stress.
7. Range of stress (from minimum to maximum) and magnitude of the mean stress in the cycle.
8. Degree of biaxial or triaxial stress at the critical section.
9. Previous stress history.

Now add to this array of variables the important changes caused by a marked increase in temperature! Furthermore, due to the accompanying creep and the instability of metallurgical structures at high temperatures, the elapsed time (or frequency of stressing) must also be considered.

A comprehensive discussion of fatigue of metals at high temperatures can be divided into three broad categories:

I. Moderately elevated temperatures, below the range in which creep under steady load becomes an important factor.

II. Elevated temperatures, covering the

*Professor Dolan's complete paper is entitled "Past Work in the Fatigue of Metals in the High-Temperature Field", Technical Report No. 17 to Project NR-031-005, Office of Naval Research, U. S. Navy, Contract N6-ori-71, Task Order IV.

Temperature Ranges

range in which repeated stressing and continuing inelastic deformation (creep) combine to govern the phenomenon of failure.

III. Very high temperatures, for which damage by creep becomes the primary consideration.

The division between these three temperature zones is indefinite; the transitions cover broad temperature ranges whose numerical values depend on the material under consideration. We will assume that categories II and III are the fields of primary interest, since generally the fatigue behavior of steels is not markedly affected by moderate heating above room temperature; in category I above, the endurance limit might therefore be expected to vary in approximately the same manner as the static tensile strength. Again, tests of S.A.E. 2340 steel by Moore and Jasper and of a low-alloy Ni-Cr-Mo steel by Kinney show a drastic drop in fatigue strength between 850 and 1000° F., but little significant change between room temperature and 700° F.

A recent study (Report of Task Group on "Effect of Speed of Testing on Fatigue Test Results" to the Subcommittee on Speed of Testing of Committee E-1, American Society for Testing Materials, 1950) emphasizes the fact that creep is a *time*-dependent action, whereas fatigue is commonly regarded as a *cycle*-dependent phenomenon; fracture at high temperature may result from either creep or fatigue or a combination of the two, and the accompanying ductility may be considerably less than in short-time tensile tests.

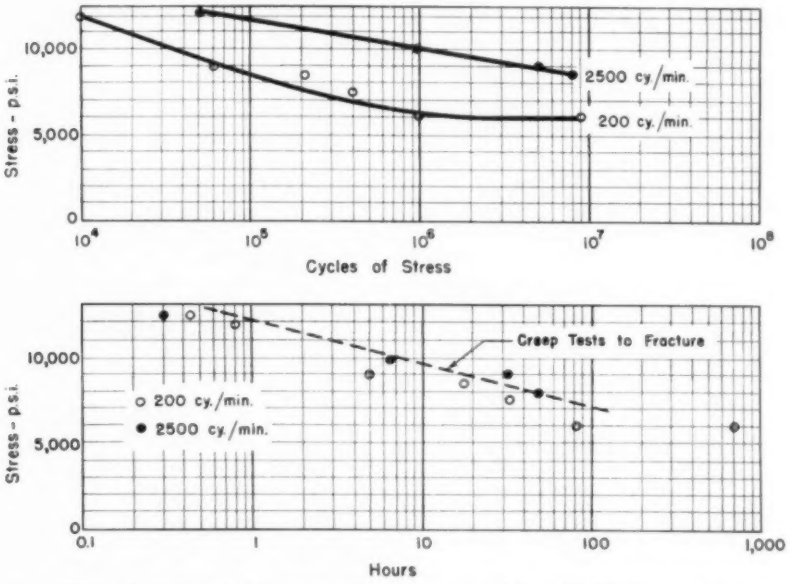


Fig. 1 — Reversed-Flexure Fatigue Tests on 0.17% Carbon Structural Steel Indicate That S-N Curve at 1200° F. Is Higher With Reversals of Higher Frequency (Top Curve). However, when stress is plotted against time, the gap is narrowed to a small "scatter band" near the line for stress-rupture from creep. (Moore and Alleman, *Proceedings*, A.S.T.M., Vol. 31-I, 1931, p. 114)

A part may sometimes be subjected to creep without the superposition of repeated stress, but above certain temperatures repeated stressing cannot be imposed without the simultaneous occurrence of creep. Thus, even under cyclic loading, creep might be primarily responsible for final fracture of the piece. This interaction may result in a total life quite different from that predicted.

In ordinary fatigue tests of steels at room temperature, results are not appreciably affected by varying the frequency of stressing over a fairly wide range. However, under simultaneous cyclic stressing and corrosion, or cyclic stressing at elevated temperature,

the accumulation of damage* depends on time as well as on the number of cycles of stress. The time-dependence of damage (by creep or by corrosion) may explain why there seems to be no definite endurance limit in tests incorporating these variables—the S-N diagram is found to be a downward sloping line, even after hundreds of millions of stress cycles.

If the stress frequency is relatively low, the testing time may be long, whereupon considerable time is available for damage by creep, and specimens may fail under fewer cycles of a given stress, in contrast to high stress frequency. Furthermore, the longer time of test may markedly alter the strength characteristics of the material, if precipitation hardening or aging occurs at the test temperature.

Effect of Cycle Frequency

Data on effect of cycle frequency are scarce, but have been plotted for a 0.17% carbon steel tested at 1200° F. (Fig. 1). The S-N diagram (upper graph) indicates that the data for 2500 cycles per min. lie distinctly above tests at 200 cycles per min. The same data replotted as stress against total elapsed time indicate that one narrow "scatter band" would represent both tests about equally well. An ordinary static stress-rupture diagram (for a similar steel), as plotted by the dashed line in Fig. 1, has about the same slope and falls just slightly above the majority of the fatigue data. However, in tests made by H. F. Moore of an 18-8 Cr-Ni steel with 0.125% carbon at 1200° F., specimens run at 200 r.p.m. withstood a *greater* number of cycles and showed a higher endurance limit than those tested at 2500 r.p.m.; this may be an indication that some change in the austenitic microstructure increased the resistance of the metal during the longer time involved in the slower tests.

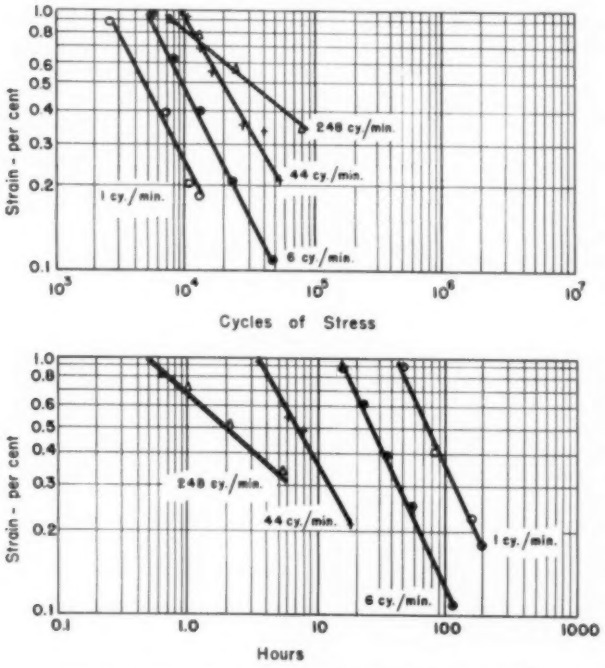


Fig. 2—Reversed-Flexure Tests on Lead Sheet at 74° F. Parallel the Indications of Structural Steel (Fig. 1) in That Increasing the Frequency of the Loads Will Increase the Cycles Required to Fracture. The lower curves, replotted against total time of test, show, however, that slow stressing increases the life greatly. (Report of Task Group on Effect of Speed of Testing, Committee E-1, American Society for Testing Materials, 1950)

Figure 2 shows tests of lead alloy strip in reversed bending at room temperature, involving four different frequencies of stressing. (Lead shows measurable creep at temperatures as low as 32° F., and hence at room temperature exhibits creep phenomena similar to those obtained for a steel at high temperatures.) At a given strain amplitude, a greater number of cycles of stress

*The term "damage" will be used to designate the general destructive effect of the various changes occurring in the material which eventually limit its usefulness. Thus, the visible damage may consist of an accumulation of permanent deformation from creep (viscous flow), plastic flow, initiation of corrosion pits, or development of cracks. These visible effects are the result of submicroscopic changes in the crystalline lattice or the intercrystalline boundary material. The processes designated by the terms slip, diffusion, recrystallization, rotation of grains, phase change, and relaxation involve varying degrees of atomic rearrangement that takes place within the material; any of these processes may constitute the initial stages of "damage".

was required to cause failure at the higher frequencies of stressing, but when plotted in terms of hours of life in the lower graph the reverse trend is noted (that is, the higher the cycle frequency the shorter the total time to fracture). As a result of their study, the A.S.T.M. Subcommittee on Speed of Testing of Committee E-1 concluded that "the data available today are not nearly sufficient to warrant any quantitative statement of effects of combined creep and repeated stress, or combined repeated stress and simultaneous corrosive action. However, it is evident that in reporting fatigue test results the frequency of application of stress cycles should also be reported."

STRESS HISTORY

In a number of applications such as gas turbines, superchargers and combustion chambers, important components operate at high temperature and under a cyclic or repeated load superimposed on a static load (such as a vibrating turbine blade carrying centrifugal loads from the high speed of rotation, plus bending or torsion from the gas impulse). In many instances the primary stress history may be suitably approximated by a sine curve superimposed on a steady or mean stress. This can usually be reproduced by carefully designed testing machines with provision to alter the mean load and alternating load to desired values.

In other important applications, however, the complex stress history may be nonrepetitive and hence cannot be simulated by any simple laboratory procedures. Often, the existing test data were obtained under conditions having only the vaguest relation to such complex conditions as met in an engine or turbine blade.

For elevated-temperature tests a distinction should be made between the applied *load*, which is controlled, and the *stress*, which is computed. (For example, the stress can be computed with accuracy only for axial load tests.) The calculated stresses imposed upon a flexural or torsional member in a fatigue test at high temperature represent only nominal values, not true stresses. The formulas upon which these calculations are based assume elastic conditions. Yet high-temperature creep invalidates this assumption. Where creep is present and elapsed time influences the strength and deformational characteristics, the real behavior of the metal cannot be adequately predicted by linear stress-strain relationships independent of time. Any specific design is further complicated by temperature gradients, stress raisers (notches or abrupt changes of section) and by metallurgical instability. Hence, no quantitative solution of these complex problems has been evolved.

A. R. Edwards, in discussing "Fatigue Problems in the Gas Turbine Aero Engine" (*Proceedings* of Symposium on the Failure of Metals by Fatigue, Melbourne University Press, 1947, p. 383), states that design calculations can now be made only for steady stresses, whereas the loads on actual turbine blades are complex combinations of steady tension with steady or fluctuating bending and torsion; such conditions are difficult to reproduce in a laboratory testing machine working at more than 1100° F. For complex conditions of this type, it is doubtful whether any of the data now available can be relied upon for accurate predictions of service life.

METHOD OF TESTING

The fatigue test and the creep test represent only two of the various criteria arbitrarily applied for appraising an alloy for high-temperature service. The various laboratory techniques include:

1. Short-time static properties.
2. "Time-to-rupture" under constant load.
3. Creep rates or total creep under constant load.
4. Stress relaxation under constant total strain.
5. Fatigue life or fatigue strength for alternating loads or for combinations of a mean load and an alternating load.

It is doubtful that any single test provides a simple or accurate index of the qualities most desired. In the higher temperature ranges, for which creep is pronounced, it usually is necessary to give some kind of weighted consideration to the results obtained from several types of test.

No general agreement exists on the most satisfactory way to carry out fatigue tests for a specific application such as turbine blading. Most of the available data have been obtained from flexural specimens subjected to reversed bending. In this test the extreme fiber of the specimen is subjected to

a completely reversed cycle of stress with the mean stress equal to zero. Here again, the stresses are computed on the basis of elastic theory, whereas the presence of creep invalidates the basic assumptions on which the flexure formula was derived.

Several laboratories have employed "push-pull" tests in axial load machines which minimize the difficulty of stress calculation, but which often run at somewhat slower cycle frequency and usually require tedious adjustment to maintain accurate concentricity and magnitude of load.

Recently Manjoine and Lazan have overcome some of these difficulties by developing modified axial load machines capable of superimposing an alternating load on a steady load, and incorporating devices for adjusting the load continuously as the specimen creeps. Both of these authors' papers appeared in *Proceedings* of the American Society for Testing Materials in 1949.

According to A. R. Edwards, some Australian machines have been built to simulate the conditions of operation by an alternating bending superimposed on a steady bending stress in a finished turbine blade while exposed to a hot gas stream. The test has proved valuable in indicating the effect of various surface finishes on the blade, but fails to include the high uniform tensile stress imposed by centrifugal effects in the engine; the calculation of significant stress is also complicated by irregular blade shape.

Even though the creep and fatigue properties appear to be satisfactory under laboratory conditions, other changes in properties that often occur as a result of the combination of repeated stressing and high-temperature environment would tend to make the material unsuitable for a particular application. It is therefore desirable that even specimens which do not creep excessively or do not fail in fatigue be given a post mortem examination to determine whether the test data may be taken at face value. Such an examination might show a lack of

Structural Stability a Factor

structural stability as observed by changes in hardness, magnetic properties, microstructure, or resistance to impact. Any such instability should serve as a warning against unwarranted extrapolation of the data to longer periods of time or higher cycles of stress, and to warn of any harmful effect that has been initiated.

Accurate measurement of specimen temperature is troublesome, particularly in rotating beam machines where a thermocouple cannot be fixed on the test-piece. Contact brushes with slip rings offer a possible but difficult solution. Optical and radiation pyrometers are not considered sufficiently accurate. Frequently faulty design, overloading, or uneven heating may be even more important than alloy composition in determining fatigue characteristics. Heat resistant parts must be designed to provide free expansion, else severe stresses that distort or crack the structure may result.

STRESS RAISERS

Little data are available on the reduction of strength caused by "stress raisers", or the manner in which they affect the creep or fatigue characteristics of heat resisting alloys at high temperature. It is practically impossible to fabricate a structure without changes of section that lead to localized stress con-

Fig. 3 — General Electric Co.'s Lastest Turbojet Engine, a Yard in Diameter and 146 In. Long, Designed for Advanced Military Aircraft

centrations. Details such as spot welds, stamped holes, minute rubbing of adjoining components, and inadequate fillets may also be responsible.

At ordinary temperatures these stress raisers are the primary "sore spots" affecting the fatigue strength of a member and its life to fracture. Presumably the same would be true at elevated temperatures if fatigue were the sole controlling factor. However, since creep is a function of the stress level, large deformations might develop in the neighborhood of the stress raiser, thereby relieving the localized concentration of stress. Under conditions combining a high mean stress with simultaneous alternating cycles of stress, the severity of the stress raiser might be less than at room temperature. On the other hand, if completely reversed cycles of loading occur at elevated temperatures, it is difficult to predict whether creep would be of any assistance in relieving the localized stress, unless the cyclic frequency be extremely slow. Any creep which occurs under a compressive stress would tend to be counteracted by the subsequent reversed creep during the other half of the load cycle. If the loads are completely reversed with high frequency, the range of strain (and perhaps the corresponding range of stress) in any one cycle might not be materially affected by the creep conditions which occur during the test.

Some German data published by W. Bertram on effects of notches and of prior cold work on the torsional fatigue strength of carbon steel at temperatures up to 1110° F. are only roughly qualitative, since the test techniques would not be regarded as suitable today. However, his results indicated that threads produced as great a proportionate reduction of fatigue strength in specimens tested at elevated temperatures as at room temperature.

Until the recent work of Jones and Wilkes,* no quantitative evaluation was available for the relative notch sensitivity of metals at high temperature. Their work indicated that elevated temperature (1200° F.) does not appreciably lower the notch sensitivity of S-816 and Timken 16-25-6 when tested in reversed bending. However, the influence of a given notch depends on how it was made. A notch severely ground in one pass (with a shape that gave a theoretical stress concentration factor of 2.7) reduced the fatigue strength at room temperature by a factor of 5.0, whereas at 1200° F. the strength was reduced by a factor of 2.4. The same notch when machine cut divided the strength by 1.8 at room temperature, and 2.0 at 1200° F. The authors attribute these differences to residual stresses caused by the method of manufacture, and their partial relief at elevated temperature. Nevertheless, it is important to note that the reduction in fatigue strength at high temperature is comparable to that ordinarily obtained for steels at room temperature; in other words, the presence of simultaneous creep does not markedly alleviate the damage caused by the stress raiser.

No information has been published on the relative strength reduction caused by stress raisers when the stresses are *not* completely reversed in each cycle.

*"The Effect of Various Treatments on the Fatigue Strength of Notched S-816 and Timken 16-25-6 Alloys at Elevated Temperatures", by W. E. Jones, Jr., and G. B. Wilkes, Jr., American Society for Testing Materials, Preprint 35, June 1950.

SUMMARY AND CONTINUATION

In a review of the principal concepts of fatigue at high temperature as illustrated in laboratory tests in relation to service experience, it becomes evident that interaction between time-dependent creep and cycle-dependent fatigue results in a rate of progressive damage which may be quite different from that predicted from simple superposition of effects obtained in separate tests. In evaluating the significance of the data, the following factors must be given careful consideration: *(a)* the frequency of repetition of the stress cycle; *(b)* the metallurgical instability of most metals at high temperature; *(c)* the influence of surface effects such as erosion, oxidation, or chemical changes; *(d)* the accentuation of time-dependent creep caused by the superposition of a mean or steady stress; and *(e)* the pronounced reduction of fatigue strength caused by "stress raisers".

In a subsequent article some data concerning steels and other alloys now in wide use will be reviewed, and some recommendations made on the type of information which must be available to the metallurgist who can successfully "design" a new material for critical services.

White Brass Plating— One Solution to the Nickel Freeze

By Webster B. Knight, President, Knight Plating Co., Detroit

VIRTUALLY THE ENTIRE national supply of nickel is being pre-empted through allocation and control of its use by the National Production Authority. Such control (as exemplified by N.P.A. Orders M-14, M-80 and others) has effectively disrupted electroplating practice where nickel and copper have conventionally been used as underplates for chromium-finished metal parts. The original schedule bars nickel (including secondary or scrap metal) in some 140 commodities. As this is written, the "death sentence" is expected to be extended to other products, amounting to practically a complete ban on nickel plating in any form.

The pinch has been particularly painful in the automotive industry which has been stepping up its applications of copper-nickel-chromium plating with each succeeding new model. The initial restrictions on nickel affected decorative parts but exempted functional parts such as bumpers, door handles, hub caps and certain types of screws. Even where nickel is allowed, it has proved most difficult to buy anodes. Platers were forced to turn to scrap metal and were almost immediately confronted with a preceiling price climb to as high as $2 a lb. Many plating shops thought nothing of paying $1.25 a lb. for nickel, and another 25¢ a lb. for melting it down to usable anodes—this against a ceiling price at the time of 65¢ for new nickel anodes.

Faced with these conditions and with poor prospects of any relief for a long time, the platers started a frantic search for alternative methods. Meanwhile, what nickel was available was used sparingly. The usual 0.001-in. thickness on parts for exterior or outdoor use was trimmed by as much as two thirds and in some instances little more than a flash was plated over a heavier copper base. The search took many directions, some obviously impractical. Tin-nickel, tin-zinc, tin-copper (speculum), titanium, zirconium, cadmium, zinc, and doubtless other metals and alloys were studied for their plating possibilities and rejected.

Investigations simmered down to about five practicable alternates for automotive plating. Each has its drawbacks, but at least they are all workable and fit demands for materials which are readily available domestically and are not too far out of line from the cost angle. They may be summarized as follows:

1. Flash Chromium Plate Over Type 430 Stainless Steel is perhaps the most widely used alternate. Straight chromium stainless steel is actually in overabundance at the moment and may be used on decorative parts such as moldings either with or without a flash chromium finish. Without the chromium, the steel does not provide an exact color match with plated parts and extra buffing is needed to bring up a comparable luster. Buffing usually has to precede even the flash chromium finish, since the plate will not level out scratches.

A further disadvantage is that Type 430 stainless is difficult to work in complicated sections and would not be adaptable to such pieces as door handles, knobs and buttons normally produced as zinc die castings. The basic cost of stainless is rather high at 35¢ a lb., figuring in the necessary extras for gage, finish, and packing.

2. Heavy Copper, Flash Nickel and Chromium, Plus Lacquer—A complete freeze on nickel would rule out this technique which has been used widely on a number of automotive parts. Its advantage is that existing plating machines can be used, except that the time cycle in the nickel solution is reduced to effect a 70 to 90% saving in anode requirements. Corrosion resistance is bound to suffer, even with lacquer protection, and it is recommended that such finishes be treated regularly with wax or oil as an added safeguard against pitting.

3. Heavy Copper, Chromium Flash, Plus Lacquer—With nickel eliminated, the base metal (steel or die casting) must be buffed

Substitute Combinations

thoroughly, either before or after application of copper. Buffing is a costly operation and in repetitive manufacture is avoided as much as possible. However, the author's company has built a high-speed automatic machine that will buff heads of ⅞ x 8-in. sheet metal screws at a rate of 73,000 per hr. The same production with manual rack buffing would require seven men working a full day.

With this finish, as well as No. 2 above, additional equipment is required to apply a baked synthetic lacquer to the chromium, and handling costs are also increased. Ability of the lacquer to stand up under weathering remains to be proved conclusively.

In barrel plating of small parts such as screws, rejects of parts plated with chromium on copper may run high — occasionally up to 75% — because of imperfect coverage. This involves a tedious and costly job of hand sorting, stripping and re-running the rejected pieces. Copper also tends to "color through" the thin chromium layer.

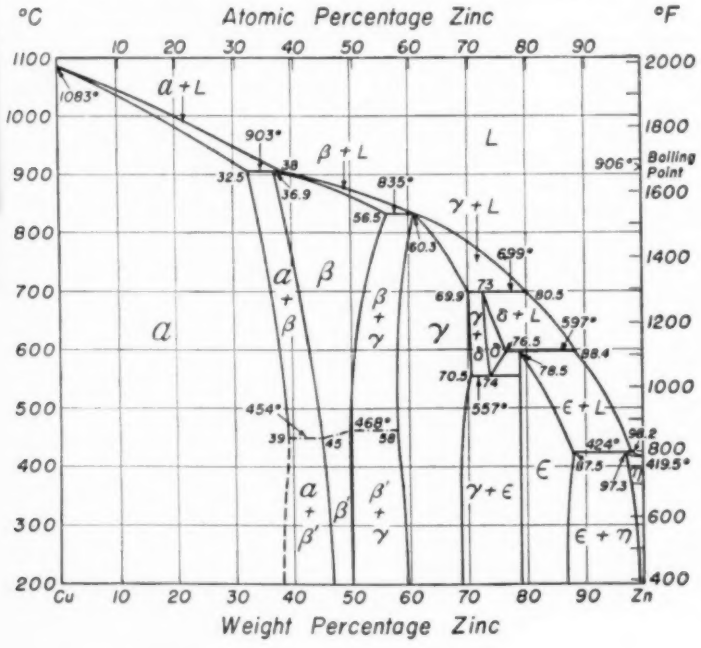
4. Bright Zinc, Chromate Dip, Plus Lacquer — This type of deposit has been used extensively on both steel and zinc die castings. Advantages include low-cost materials with good availability. On the adverse side must be recognized poor matching qualities against chromium plate or stainless steel, a relatively soft plate which oxidizes to white corrosion products quickly, and poor retentive power for lacquer. Also, even a small trace of copper in bright zinc means a spoiled job.

5. White Brass, Chromium Flash — This is an entirely new departure in electroplating, still in its infancy and not widely known or understood. Its possibilities are, to say the least, intriguing. White brass anodes are approximately 80% zinc, 20% copper; solution is the cyanide type; best deposits thus far are in the range of 0.0002 to 0.0003 in. Advantages are that *(a)* conventional nickel plating equipment can be converted easily to white brass; *(b)* plating time is shorter than for copper-nickel; *(c)* adherence is good; *(d)* resistance to corrosion in salt spray tests far exceeds minimum specifications for copper-nickel-chromium.

The writer's company began experiments with white brass in the fall of 1950 for barrel plating of sheet metal screws formerly chromium plated in the conventional manner. The first production plating unit went into operation last March, and since that time about 100,000,000 screws have been processed.

It may be well to emphasize the fact that white brass plating is a technique that is altogether dependent for success upon the skill and ingenuity of the individual plating specialist. There is almost no literature covering the process. No single source or supplier can furnish full data on its application. It is not suggested as a cure-all for current shortages of nickel, for there are serious limitations which must be recognized at this time.

Fig. 1 — Copper-Zinc Constitution Diagram Illustrates Metallurgy of Anode Alloys in the 80% Zn, 20% Cu Range. A casting temperature of at least 1300° F. is required. (Diagram according to Arthur Phillips and R. M. Brick, Metals Handbook, 1948 Edition, p. 1206)



Apparently the first recorded mention of white brass plating was in 1938 when Wernlund and Opplinger, two chemists and plating experts of E. I. du Pont de Nemours & Co., Inc., described the process (see *Plating*, Vol. 39, No. 1, January 1952, p. 89). Anodes of 80-20 zinc-copper were used in a solution of 8 oz. per gal. each of zinc cyanide, sodium cyanide, and sodium hydroxide, and 2 oz. per gal. of copper cyanide. Brighteners such as "Zinolyte" and sodium molybdate were added. A current density of 20 amp. per sq.ft. was recommended for bright deposits; solution was at room temperature, with agitation and electrolytic purification.

Unfavorable factors in early work were brittleness of the deposit accompanied by high internal stress, tarnishing, peeling and blistering, which apparently increased as the deposit became thicker. Recent work has overcome these objections to a degree, and brightness of the deposit has been improved by new addition agents, brighteners, and secondary additives.

The 80-20 zinc-copper anode alloy is a basic analysis and slight variations can be made for desired results. Higher copper has been found to increase brittleness, while higher zinc tends to lessen receptivity for subsequent chromium plate. In other words, as zinc content becomes higher, good chromium coverage becomes progressively more difficult.

Figure 1 shows the copper-zinc constitution diagram. Few metallurgical references can be found to alloys at the high-zinc end. Above 70% zinc the liquidus line drops rapidly from 1450° F. (787° C.) to 1300 at 80% and on down to 800 at 97%. A eutectoid forms at 76.5%, with alloys on the lower side precipitating to a mixture of γ and ε phases, and on the higher side to ε phase alone. At 87.5% zinc another eutectoid forms at 795° F. (424° C.). Still higher zinc gives mixtures of ε and η phases.

Thus, in casting the anode alloy in the 80-20 range, a temperature of at least 1300° F. is required, and even higher as zinc content is lowered slightly. Solidus temperature at 80% zinc is 1107° F. (597° C.). High-purity metal is essential in casting the plating anodes, "four-nine" (99.99%) special high-grade zinc and electrolytic copper being used. The alloy tends to attack metal molds in which it is poured, requiring special precautions.

Close laboratory and operational control is a "must" in white brass plating. Steel parts must be cleaned thoroughly if no preliminary copper plating is used. Plating of copper under white brass is optional; experience indicates little value on steel but possibly some benefits on zinc die castings where it acts to "seal" the surface tightly. Solution chemicals must be mixed carefully and a continuous check made on the bath during production. A day's run usually can be made without the need for bath makeup. Agitation of the solution has not proved necessary with barrel plating; it may be advisable in still plating. Continuous filtering has not been imperative.

In early experimental work the white brass plate had a tendency to be extremely brittle, anode corrosion was poor, and the bright plating range of the solution was narrow. An effort to correct these difficulties by adjusting the chemistry of the bath met with little success. As might be expected, agitation did extend the bright range somewhat; however, it did little to eliminate the brittleness. In fact, if agitation was too severe, the tendency toward brittleness actually increased.

At this point work was directed to finding a suitable secondary brightener — one that would increase the bright range and promote anode corrosion. It was hoped that some grain refinement would also result in the alloy plate, thus improving ductility. Several different compounds were tried. One in particular showed promising results and seemed to meet the desired qualifications as well as stabilizing the plate or retarding the tarnish often associated with white brass.

Successful application of the technique to barrel or bulk plating stimulated interest in what might be done with still tank or rack plating. Our company began a study last November, with the idea of developing a practicable method for deposition of white brass from a still tank solution. The method should meet the following criteria: *(a)* a uniformly bright plate; *(b)* a good base upon which to plate chromium; *(c)* a combination of white brass and chromium that will withstand baking without cracking (where baked lacquer is applied); and *(d)* a plated part that gives adequate protection against outdoor corrosion.

A 250-gal. tank was installed in the production plating shop as a pilot operation

Pilot Plant Results

and duplicated results obtained in an 8-gal. laboratory tank at every step of the way.

Cost of the project over a one-month period approximated $2600, including $1300 for the tank, circulating pump, piping, wiring and installation labor, $415 for technical supervision, $500 for a microscope to check defects, $250 for chemicals to make up and maintain solutions, $90 for racks, and something over $40 for production labor (polishing and buffing test pieces and filtering the solution).

A test run was made in December on four stamped steel radiator grill elements. A deposit of 0.0003 in. of white brass was applied in approximately 20 min. This compares with 23 to 25 min. for 0.0003 in. of copper and another 36 min. for the conventional 0.001 in. of nickel. In appearance the white brass is quite close to chromium, except for a trifle more cloudiness. It has no "brass" color whatever and none of the yellowish cast of nickel plate or chromium-nickel stainless steel. A deposit of 0.00001 in. of chromium was flashed over the white brass prior to exposure in a standard salt spray test. After 24 hr. no evidence of corrosion was detectable; after 36 hr., light, white corrosion products appeared in the form of small specks which washed off with water; after 48 hr., corrosion products were a little heavier but could be removed with polishing compound. No tarnishing or loss of brightness was observable after the salt spray test.

It is true that the salt spray method of testing electroplated coatings is not a satisfactory method for evaluation in actual service, such as likely to be encountered by an automobile radiator grill. However, it does provide a basis for comparison between different plated metals and varying thicknesses of plate. Even prolonged outdoor exposure tests of plated panels are not regarded as the final answer.

Importance of the chromium plate deposited over white brass as additional insurance against corrosion should not be underestimated, despite its almost microscopic thinness. It has been apparent in our work with barrel plating of white brass and chromium that the quality of the latter determines to a high degree the worth of the total plate. Those who are familiar with chromium plating know that the deposit often is marked by a network of fine hairline cracks. This has not been noticed on small pieces plated in barrels as much as on larger parts racked in still tanks. Production of a crack-free chromium plate in still tanks, the writer feels, is a distinct possibility and work is proceeding toward this end. The answer may lie in some solution additive such as aluminum sulphate, or in more precise control of solution analysis. Once the method is perfected, the salt spray resistance of white brass plus chromium will improve still further.

Bulk plating equipment in our shop has been converted from nickel to white brass without great difficulty. Equipment originally built to produce heavy nickel plate (0.001 in. in 45 min. to 2½ hr.) with an average load of 75 lb., has now been changed to white brass, holding 4000 gal. of solution and depositing 0.0002 to 0.0003 in. in approximately 15 min. White brass also is being plated in standard submerged plastic-type barrels, with plating time about 30 min. for a 200-lb. load. All tanks must be lined and are operated at 75 to 100° F.

Current densities as high as 100 amp. per sq.ft. have been used in still tank plating. In barrel plating they are anybody's guess. Years ago we eliminated tank rheostats and meters as a useless expense and hindrance in bulk plating, since it is practically impossible to know the area of work effectively exposed at any one instant to the plating solution. Line voltage is set at about 14 volts.

On screws which used to be given the standard finish of 0.0003 in. copper, 0.0004 in. nickel and chromium flash, time in the salt spray test to the appearance of red rust averaged about 32 hr. The same parts with white brass plus chromium have withstood up to 100 hr. in salt spray before red rust appeared. Such results indicate that white brass may well wind up as a standard underplate for chromium-finished screws.

The future of the method as applied to larger racked parts remains uncharted. Preliminary experiments look good. Automotive companies are intensely interested, since many of them operate large, automatic copper-nickel-chromium installations costing hundreds of thousands of dollars. This equipment is now in danger of enforced idleness unless it can be converted to some other process. White brass looks to be a "natural", although much more work remains to be done and time is of the essence.

The Impending Revolution in Casting Processes

By H. H. Harris, President, General Alloys Co., Boston

IN THE CASTING OF METALS, a long delayed revolution is gaining headway. Many progressive men, producers and consumers of high-grade foundry products, are viewing the possibilities of processing fluid metal into parts of high integrity and close approximation of finished form. Defense needs are pressing for engineering development. As Major General Fred R. Dent, Jr., commanding general of the Wright Air Development Center, stated in an address before the October 1951 meeting of the American Ordnance Assoc. at Cincinnati, "We court disaster unless every facility for our technical superiority is effectively utilized now." Engineering developments can carry the U. S. casting industry to much higher levels of application and service. This impending revolution will cross technical horizons and industrial frontiers, expand progress in cast metals for war, and then on through the readjustments for peaceful times.

All credit is due to those who are speeding the production of conventional castings by materials-handling equipment and the adaptations of traditional processes to reduce time cycles, despite a sharply diminishing supply of skilled and unskilled labor. They apply managerial ability to meet the rising demands of commercial castings in the third recurrent (and woefully unplanned-for) war-cycle in a lifetime. If history repeats itself, and it probably will, many of these progressive men will expand their operations for emergency production far beyond the capacity for peacetime production, and will bear the brunt of destructive competition by mediocre outfits during the eventual downswing.

The virile response of the foundry industry, with increased tonnage in emergencies — as well as its traditional lethargy in advancing its technology so as to compete with fabrications and forgings — is too well known to bear repetition. We acknowledge and point with pride to each foundry, large and small, clean and dirty, which, under present abnormal shortages in labor and materials, can compete for labor and materials, as well as for markets, with quasi-subsidized industries operating under a much higher margin.

Recent Developments — In this article we are primarily concerned with recent developments in the arts and sciences in "casting" of metals and their possible and probable benefit to defense and the national economy. What are the potentialities of high-integrity cast products in national defense, in ordnance, in aircraft, ships, submarines, missiles and radar? (By "high-integrity" is meant cast products of metallurgical, physical and dimensional excellence.) It is obvious that there is great need in all such fields for parts with increased strength, lower weight, and decreased cost and time of machining, fabrication, and assembly. It is mandatory then that the responsible executive and engineering personnel rise above their previous concepts of the quality of cast products if every pound of American metal in combat and behind the lines is to perform more work than the enemy can exact from each pound of his metal.

Many metallurgists, engineers, and foundrymen have held to such a high goal as is indicated above; they have persistently endeavored to gain more and more information and skill, so that castings of such high integrity could be produced commercially. These men of vision, seeking to catch up with technical progress in automotives, machine tools, hydraulics, electronics and other fields, have laid such foundations as now exist for the impending foundry revolution. What one man can do, another can follow and undoubtedly improve upon.

Inasmuch as castings strong and light enough to fly as components in a modern

EDITOR'S NOTE — Mr. Harris is currently directing a "Casting Potentials Project" for Air Materiel Command, U.S.A.F., as noted in the personals columns, p. 90.

Dimensional Accuracy

airplane can function most anywhere, this article will primarily deal with casting potentials in aircraft. The aircraft industry comprises, in fact, the most rapidly expanding sector of American defense and the fastest growing factor in American transportation. Unfortunately, however, no two fields are now further apart than aircraft engineering and conventional foundry engineering. If airplanes were built like tractors, they would never leave the ground. If tractors were built like airplanes, you couldn't swap the farm for the tractor. Part of this situation is due to the fact that the military planners and the aircraft industry have largely ignored the foundry while they have spent lavishly on improved forging, rolling and forming processes. This is a serious oversight which must be corrected without further delay. (Remember General Dent's remark quoted in the first paragraph.) Entirely apart from engineering considerations, forgings (and forging machinery) of large enough size for current airplane designs are unavailable; *action* on the production of large castings is imperative.

¶ Each industry, and to a large extent each individual, has a different concept of "castings". The justified reservations and the unjustified prejudices each man bears toward castings create psychological obstacles more difficult to surmount than the measurable technical considerations. The more that men's minds are entrapped in the past, the less they can conceive the future. Let us forget the terms "casting", "forging", and "fabrication", and think in terms of "metal parts of controlled metallurgy and predictable structure, strength and fatigue performance", regardless of the process by which they are made. Metallurgy, with modern controls and melting equipment, *can* be as well controlled in castings as in milled products. This is fortunate, for many useful materials can be cast which can be rolled or forged only with the greatest of difficulty.

INGOTS ARE CASTINGS

Do not forget, also, that all rolled materials start life as castings. Ingots are cast in metal molds. The molds are coated with pitch, clay, lime, and other dirt and gas-producing materials. The ingots are so frequently "dirty" and "porous" that these words are common in steelmakers' jargon. Surface condition of most ingots is so bad that chipping, scarfing, grinding and cleaning costs are high. Gas trapped in metal ingots is so commonplace that much refining and pouring practice is designed to eliminate or control it. Dirt and gas are less in ingots than in the most contaminated and gassy castings only because the latter are made in sand molds containing much moisture and combustible organic binder. On the other hand, castings made from melts properly melted and transferred, and cast in metal or nonorganic molds (die castings and permanent mold castings), are as clean as any ingot.

For centuries castings have been produced to closer dimension and in much more complex form than forgings. Few metallurgists will argue that a sound, clean steel casting cannot be produced in any forging analysis, and heat treated to a suitable microstructure offering equivalent physical properties. Several leading materials engineers in the aircraft industry have stated that clean, properly heat treated steel castings can be used interchangeably with forgings. The principal obstacles to their use in aircraft (and, to various degrees, in other high-stressed applications) are variations as yet inadequately predictable in X-ray sound-

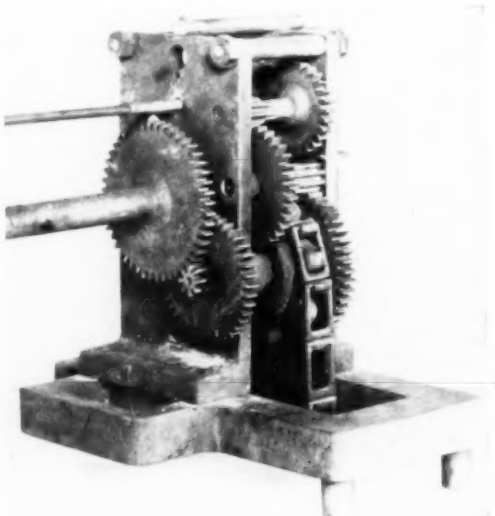


Fig. 1 — Working Gears Cast by General Alloys Co. as Long Ago as 1928 for a Clock That Kept Time at a Sustained Temperature of 2000° F.

ness, in as-cast structure, or in the results of the relatively crude heat treating operations "economically dictated" in foundries. Excessive and unnecessary variations in chemical composition are common. There are currently no standards for surface finish on castings and, in general, no standards for as-cast structure.

Most variations in today's castings, other than those caused by organic materials in conventional sand molds, can be largely eliminated by processes and controls which have already been demonstrated, many in commercial practice, and which could be expediently employed in many plants by a general upgrading of technology, operating personnel and instrumentation. Better inspection *at the source* would eliminate most of the scrapped, partly machined castings currently a major deterrent, with the delays and complications associated with their replacement, to their use in many applications.

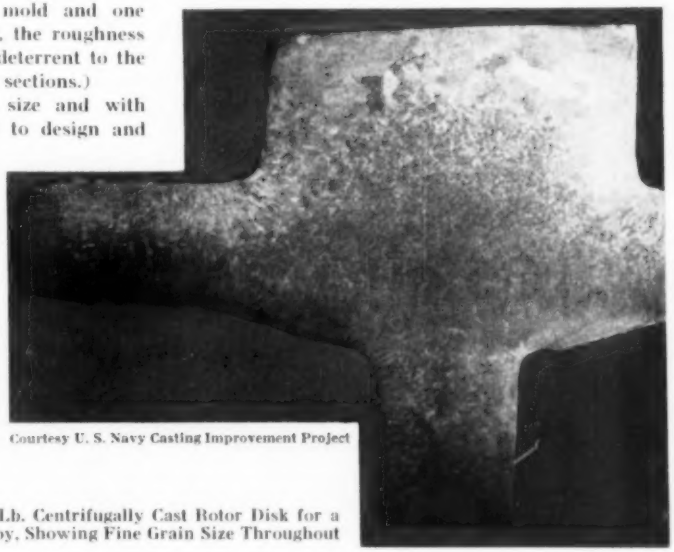
Aluminum and magnesium castings possess a wide variety of physical properties depending upon the foundry processes. Apart from cleanliness of metal (related to melting practice and mold materials) permanent mold and die castings have improved solidification processes. Improved conductivity of metal molds and controlled conductivity of nonorganic molds offer great advantages over sand. (It might be noted in passing that there is a large difference in actual area presented to the metal in one square inch of a smooth mold and one square inch of a sand mold, the roughness of the latter being a major deterrent to the running of metal into thin sections.)

With controlled grain size and with controlled processes related to design and use, microstructures and macrostructures can be studied, standardized and specified in relation to the chemical analysis of the alloy being used. A very wide range of mechanical properties, far beyond those expected from conventional castings, can be obtained. Many known high-strength alloys, now thought too difficult to handle, or resulting in prohibitive amounts of scrap (including many analyses favored by rolling mills and forge shops), can be cast by advanced processes.

Here lies one of the greatest challenges to the metallurgist in a generation. With the controls of the laboratory, advanced and extended to the shop, literally *new* materials with unique properties will become available for casting, offering the designer a latitude in variety and continuity of form in high-strength materials heretofore unavailable.

Currently there are differences of opinion as to the importance of grain size to shapes made of the light metals. Certainly each alloy must be separately considered. It is indisputable, however, that a great improvement in density (continuity of structure) is obtained by temperature controls and by pressure, and that such improvement leads directly to advanced mechanical properties. All would prefer magnesium castings (for example) as sound, continuous metal rather than metal surrounding oxides or shot through with porosity, fine or coarse.

Current data used by aircraft designers allow approximately 33,000 psi. ultimate strength for aluminum sand castings and 70,000 to 75,000 psi. for aluminum forgings. It is not generally known but it is neverthe-



Courtesy U. S. Navy Casting Improvement Project

Fig. 2 — Section Through 340-Lb. Centrifugally Cast Rotor Disk for a Gas Turbine Made of N-155 Alloy, Showing Fine Grain Size Throughout

Tooling Is Key to Improvement

less true that advanced casting processes in commercial production are producing aluminum castings with ultimates well over 60,000 psi., yields of over 50,000, and elongations over 10% — in short, close enough to forgings so that the casting's inherent advantages of continuity, tri-laminar structure, and reduced limitations of shape offer a new horizon to designing engineers.

Accuracy also is noteworthy. Aluminum castings made by advanced processes are in commercial production with tolerances closer than any claimed for so-called "precision" castings (±0.002 in. in 14 in. and a 5 micro-inch r.m.s. as-cast surface is one example).

The need for improved methods of melting and handling the highly oxidizing light metals has long been obvious. Some such methods are in commercial production on a small scale. It is certain that melting and pouring such metals in the open air and relying on their low gravity for pressure in the mold will turn out a vastly inferior product to those which can be produced by *(a)* keeping air, moisture, and products of combustion away from the molten metal in all steps of process, *(b)* by applying pressure to the metal while it is solidifying, and *(c)* controlling the temperature of the metal throughout the entire process.

If one is only concerned with *relative* cleanliness, *relative* density, *relative* strength — just enough to satisfy certain markets with relatively low standards — *any* existing foundry practice, no matter how crude, can be justified in varying degrees for specific applications. On the other hand, when we think in terms of castings with maximum physical properties, maximum cleanliness, and with tolerances close enough to eliminate most or all of the machining, we are on a different plane of reference — nevertheless one which is entirely attainable and practicable in production.

The key to improvement in foundry processes, as in any other process, is tooling. Entirely apart from the question of mold materials or melting practice, no casting can be dimensionally more accurate than the pattern or the machines and rigging employed in mold production. The inherent precision of the tooling, for example, determines the accuracy of the pattern. The free-hand machining of patterns from wood, and the hardly less crude methods employed for most metal patterns, are good enough for castings that are subsequently machined. How much smarter and cheaper to make a precise pattern, taking the stock off the pattern *once* instead of cutting it off from every casting made therefrom forevermore! One million dollars spent in advanced foundry tooling will save $5,000,000 in machine tools (if and when the latter are available).

Let us ask this hypothetical question: What ways and means would a seasoned engineer, lacking foundry experience, suggest for making high-integrity castings? It is exceedingly doubtful if he would follow conventional methods or employ conventional foundry equipment. If he did, in all likelihood he would wind up with rough castings commonly used in defense production, so oversize that anywhere from 50 to 90% of their weight is reduced to chips. It is equally certain that no one wishing to produce the cleanest possible casting would melt and pour the metal in contact with the atmosphere (for example, pour 3000° steel into an 1800° ladle with the accompanying disintegration of refractories) and then pour it into a mold in contact with live steam and

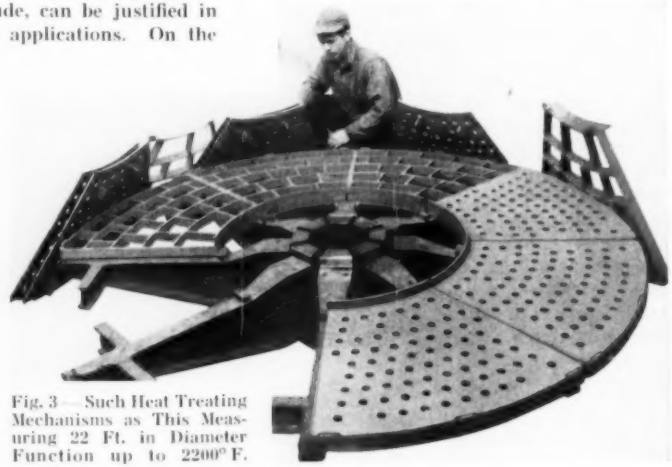


Fig. 3 — Such Heat Treating Mechanisms as This Measuring 22 Ft. in Diameter Function up to 2200° F.

hydrocarbons from burning organic binders.

No revolution in the foundry industry will occur overnight. Few foundries, now busily employed with a backlog of orders, are likely to make revolutionary changes, but each one can make substantial improvements by adopting advanced controls in various degrees. All of these will be economically justified in terms of increased yield, reduced scrap, and reduced cleaning and machining costs.

Radically new practices, fully employing the known advances, should preferably be set up as independent pilot units with a high fence separating the operation from the "old-timers". It is infinitely harder to teach old dogs new tricks than to train young ones, particularly when the engineering schools can do part of the job. (Most of the brains will be built into the tooling.) Accurate tooling, controls, and inspection will also avoid much of the trouble to be expected from variations in the skill and reliability of workers and supervisors.

There are, God bless them, a few exceptional old-timers who, with a wealth of experience, can still evaluate their own ignorance; who embrace the future rather than the past; who know that growth and progress can only come through *change*. It is the writer's firm belief that, in the immediate future, enterprising foundrymen who choose to advance and render a greater service to the nation will follow three courses:

1. Apply such elements of advanced foundry technology and controls as are applicable with no major changes in their present melting and molding equipment and will return profits on premium products.

2. Set apart some portion of their facilities as a pilot production unit manned by qualified personnel and equipped primarily for a new process, and utilizing conventional cleaning and, possibly, melting facilities, supplemented as required.

3. Go whole-hog for a new plant or a new division set up and tooled for highly advanced processes, without compromise, when they are convinced that a radically new process is necessary to advance the national defense. (How many such pioneering souls will come from outside the "foundry" is a large question. Will independent foundries pioneer in new markets, or will "captive" foundries take the lead?)

In conclusion, leaders who strive to excel, to make a profit today and insure a profit tomorrow, are not content to hang on to a lot of usable yet obsolete equipment. There never was a better market for it! There never was a better opportunity, market or subsidy (taxwise) for technical advances. As the board chairman of Jones & Laughlin Steel Corp., Admiral Morrell, has said, "You can't do today's job with yesterday's tools and be in business tomorrow."

We repeat in bold letters:

Tooling is the essence of quality and quantity.

Where automotive and aircraft engineers frequently design and often build their own special tooling, few foundries employ requisite engineering talent. They traditionally rely on the equipment manufacturer and buy the popular equipment, thus enjoying little or no competitive advantage. In this way, standardization — too often at a mediocre level — rather than engineering progress is served.

The challenge to the foundry equipment producer and the rewards of progress are as great as to the individual foundryman. He upon whom the foundry depends for its engineering and process has a moral obligation, as he sets the pace for the industry he serves. A generation ago we had two types of production, *(a)* quality and *(b)* quantity. Experience has taught that, once the tooling and controls are established for quality, quantity production and cost reduction follow. It is, in fact, a natural law: The best way to do a thing is always the cheapest.

Finally, let me reiterate the conclusion I have reached after a wide and intensive study of the problem: There are many specialized items now required for defense which are held up by bottlenecks in forging or machining equipment, yet which could be produced by specialized casting practice employing equipment that can find peacetime application in many specialized and profitable fields. It is to be hoped that this situation will generate many developments in foundry processes throughout the nation.

The room for improvement is ever-present. The means are at hand or attainable. That we may grasp and employ *all* new technology in advance of our enemies is the fervent hope of all of us. Informed, incisive action is demanded. Too much time has been lost. Advance of process, industry defense, and national security are synonymous.

Power From the Atom

PERHAPS the most important statement in the eleventh semi-annual report of the U. S. Atomic Energy Commission to the Congress was the following: "The Department of Defense and the AEC carried on an intensive study of the feasibility of undertaking a further important expansion of atomic energy production facilities.* The report on this study was filed with the Joint Committee on Atomic Energy, 82nd Congress, earlier this month." This statement was made after another one which cited the estimate that 3% of the nation's total building expenditures are currently going into new atomic energy facilities.

A major part of the report concerned research on plants using radiation or radioisotopes. From other pages devoted to the Commission's actions, the following is extracted verbatim concerning reactor developments:

New Reactors — The experimental breeder reactor at the National Reactor Testing Station in Idaho was brought up to criticality. This is the first reactor of appreciable size to operate with fast neutrons, the first fast reactor being a very small unit at the Los Alamos Scientific Laboratory. Already, valuable information has been obtained on the new design. It will be months, however, before the feasibility of breeding can be determined. Many factors will have to be considered, such as the investment of fuel required in a large breeder reactor and in its plants for processing and fabricating fuel elements, the time required to double the amount of fuel invested, and construction and operating costs.

Power Generating Experiment — Electrical power was first generated here [in the above-mentioned fast reactor] on Dec. 20, 1951, at the rate of more than 100 kw. and used to operate equipment and light the building. The heat energy produced in the reactor was removed by a liquid metal at a temperature high enough to generate steam to drive the turbine.

Power generation is incidental to the main experimental purpose of the reactor [to test the feasibility of "breeding"] and is to secure information on the handling of liquid metals at high temperatures under radioactive conditions and on the extraction of heat from a reactor in a useful manner. The power plant of this reactor can never generate large amounts of electrical power, and is in no way intended to establish the feasibility of producing power economically from nuclear sources.

The Naval Reactors — Construction at the testing station for a land-based prototype of the submarine thermal reactor power plant was advanced under subcontract to Westinghouse Electric Corp. The latter will furnish the reactor and propulsion machinery for the submarine Nautilus, and the hull will be constructed by Electric Boat Co. of Groton, Conn. Work also continued by the Knolls Atomic Power Laboratory [General Electric Co. near Schenectady] on design and development for the submarine intermediate reactor, a land-based prototype of a nuclear power plant suitable for a submarine. Though similar in power specifications to the submarine thermal reactor [to be constructed by Westinghouse] this reactor will operate in the intermediate neutron energy range and is being designed along substantially different lines.

Aircraft Nuclear Propulsion — Facilities at Oak Ridge, formerly occupied by "NEPA" [design and development leading toward aircraft propulsion by nuclear power] were taken over by General Electric Co. and will be moved to Lockland, Ohio, by June 1952. This nuclear development is paralleling development of associated propulsion devices by General Electric, and the preparation of the airframe by Consolidated Vultee Aircraft Corp., of Fort Worth, Texas — both under Air Force sponsorship. The Air Force also entered into contract with the Pratt & Whitney Division of the United Aircraft Corp., East Hartford, Conn., for work on an atomic aircraft engine.

Fluidized Reactors — The homogenous reactor experiment was brought nearer completion at the Oak Ridge National Laboratory. This pilot reactor is a step in the study of fluidized reactors. Although an "experiment" by comparison with large reactors, it will have greater power than the only existing fluidized reactor, the Los Alamos water boiler, or the water boiler under construction at North Carolina State College. Like the experimental breeder reactor, it will ultimately operate a small turbo-generator for heat transfer and power studies.

Industrial Participation Studies — More than 100 engineers and scientists on the staffs of four industrial groups [headed by Monsanto Chemical Co., Detroit Edison Co., Commonwealth Edison Co., and Pacific Gas & Electric Co.] were cleared for access to the Atomic Energy Commission's data, installations and personnel. Thus, new talent is being brought into the program to develop improved reactors. It is expected that their reports will *(a)* determine the feasibility of designing and operating dual-purpose reactors to produce fissionable materials and power; *(b)* examine the economic and technical aspects of building such reactors in the next few years; *(c)* determine the research and development needed; and *(d)* recommend industry's role in such a program.

*In a press conference on Jan. 28, 1952, Chairman Dean quoted a Presidential statement that $5 to $6 billion would be spent over the next few years for additional facilities for refining uranium ore and for separating U^{235} and Pu. Dean intimated that the 7000 additional scientists and engineers would be harder to find than the money.

By R. F. Koenig and S. R. Vandenberg, Metallurgy Dept., Knolls Atomic Power Laboratory
General Electric Co., Schenectady, N. Y.*

Liquid Sodium—A Noncorrosive Coolant

THERE IS scarcely a metallurgist whose work does not involve liquid metals in some form. Metals have been handled as liquids for centuries, but until recently little systematic investigation had been undertaken on the effects of liquid metals on the materials which convey or contain them. Widespread interest in liquid metal coolants developed with the concerted activity to extract useful power from nuclear reactors. Sodium is one of the liquid metals most intensively studied because it is an excellent coolant and has acceptable nuclear characteristics. Sodium's high specific heat and low density make it economical to pump; more heat is removed by sodium per pound pumped than by any other liquid metal except lithium. It will be recalled that sodium has already been used in aircraft engine exhaust valves.

In programs aimed at evaluating the suitability of various materials for contact with sodium, a number of liquid metal corrosion tests were developed. Some of the tests and corrosion data are presented in the "Liquid Metals Handbook" (Office of Naval Research Publication NAVEXOS P-733, a joint project with the Atomic Energy Commission) and in *Metal Progress* Data Sheets for December 1950 and January 1951. The purpose of this article is to present some recent data on the corrosive properties of sodium and to describe several test methods.

In 1946, one of the principal uncertainties in the use of sodium was its corrosive effect upon structural materials. Only scattered and incomplete information existed. As understanding of the problem gradually developed, the first concept to be recognized was that aqueous corrosion and liquid metal corrosion are entirely different processes. Electrochemical action, so fundamental to aqueous corrosion, is not expected and has never been observed in liquid metals. Several attempts have been made to detect potential differences other than electrothermic between dissimilar metals in sodium, but none have been found.

Five types of attack in liquid metals are known:

1. Direct solution of a material or its constituents.
2. Oxidation by reaction with the oxide of the liquid metal.
3. Interaction of direct solution and oxidation (1 and 2).
4. Solid-phase alloying or formation of intermetallic compounds of the liquid metal with a dissimilar metal in the system.
5. Intergranular penetration.

An illustration of the first mechanism is pure iron, which appears to corrode by direct solution in oxide-free sodium. Stainless steel typifies the second condition by corroding in relatively pure sodium to the extent of a very slight thickening of its protective oxide film. Under extreme conditions, with high sodium oxide concentrations, interaction (3) is manifested in the dissolution of the constituents of stainless steel.

One example of intermetallic compound formation (4) is the combination of calcium in sodium to form a new phase on the surface of exposed nickel. Sodium reacts violently with zinc to form an intermetallic compound. The crumbling of brass in mercury is a well-known demonstration of intergranular penetration (5). In sodium at 500° C. (932° F.), stainless steels are completely resistant to intergranular attack.

Metallographic examination of specimens usually suffices to classify the type of attack when it is not obvious from changes in weight or appearance.

The most fundamental approach to corrosion testing employs solubility studies. Small containers of the material being tested are filled with sodium, and samples of the

*The present state of the art owes much to John P. Howe for his able, encouraging guidance, to Leo F. Epstein for his help in understanding and explaining the corrosion mechanisms, and to the members of the corrosion laboratory staff — George L. Cutler, Edward J. Doyle, Lennis W. Dunbar, Norman G. Mills, William K. Reed, and Frank H. Sebring — for their many contributions to the experimental technique.

Static Tests for Screening

sodium are removed at temperature after suitable periods of heating. Chemical analysis of the samples provides solubility data. From such information and from metallographic examination of the containers, an indication of the rate, extent, and manner of attack can be gained.

For most evaluation studies, a fairly standardized experimental scheme has been developed. The static corrosion test is most valuable for screening purposes, since it indicates those materials which are susceptible to attack. Similar to the beaker test for ordinary corrosion, the static corrosion test apparatus (Fig. 1) consists of a stainless steel vessel A with a flanged top which carries piping connections for an inert gas blanket and for charging and discharging sodium. A thermocouple well C is provided for controlling and recording temperature. The vessel is heated by an external electric furnace which envelops the lower two thirds of the vessel. Specimens can either be placed in individual containers of the same material (so as to avoid mass transfer through the introduction of a third material), or can be strung from racks; however, for basic work with new materials it is especially important to eliminate the effect of a third phase in the system. Individual containers are also useful for providing certain special effects involving

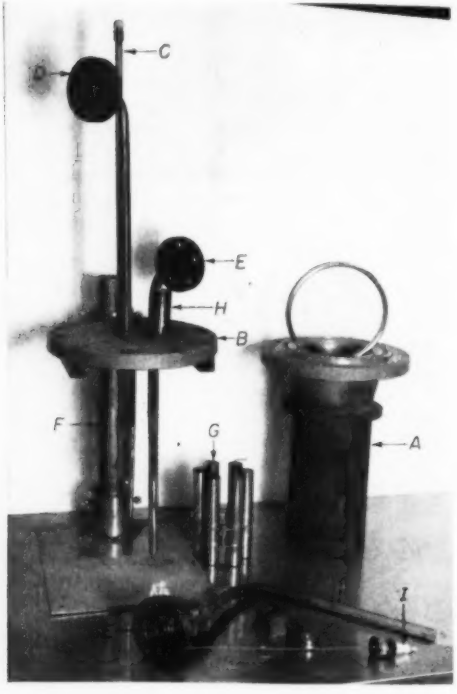


Fig. 1 — Static Corrosion Test Apparatus

A — Stainless steel container and seal ring
B — Vessel top
C — Argon connection
D — Sodium inlet line
E — Sodium outlet line
F — Standard
G — Sample cans
H — Port for level indicator
I — Spark plug level indicator

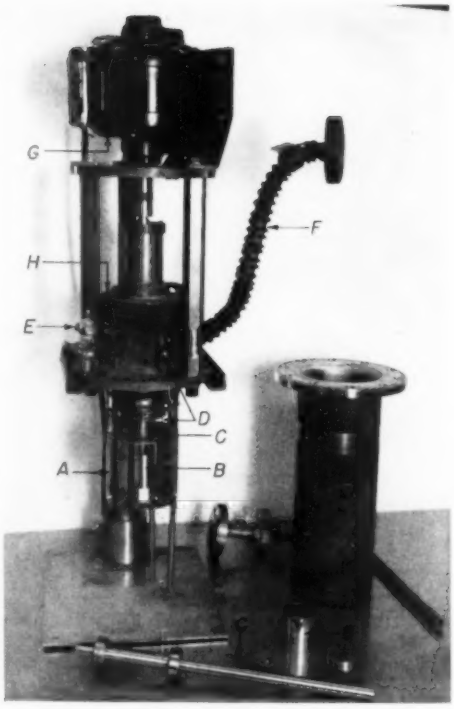


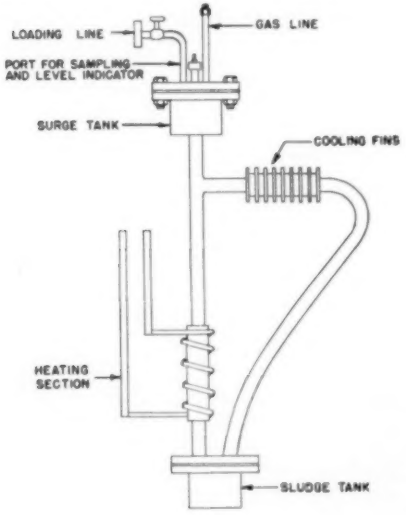
Fig. 2 — Rotating Specimen Test Assembly

A — Baffles
B, B — Specimen in place and spare
C, C — Rotating shaft in place and spare
D — Spark plug level indicator
E — Gas line
F — Sodium inlet line (wound with armored wire)
G — Motor
H — Radiator surrounding main bearing

ratios of specimen area to sodium volume.

The steps followed in making the test are somewhat unusual. After assembly and careful leak checking, the test vessel is filled by "blowing over" sodium from the melt tank. The leak test is required because even a minute leak will be enlarged by the sodium oxide which forms when the escaping sodium vapor or liquid comes in contact with air. Connecting piping must be heated during the filling operation. (Lamp-grade argon has proved a satisfactory inert gas for flushing air out of the system. Argon is also easily spotted on leaks.) When the vessel is full, the connecting pipe lines and test vessel are cooled to room temperature. The flanged filling line D (in Fig. 1) is separated and capped with a blind flange. Running the test consists simply of heating the vessel for the selected period, usually a month or more. To empty the vessel, it is cooled to 257° F. (sodium freezes at 208° F.), and the valve in the outlet dip line E is opened. Inert gas pressure blows the sodium out into an open container. After cooling the vessel to room temperature and removing the top, the specimens are placed in a can of 95% alcohol which dissolves adhering sodium. Residual sodium is removed from the equipment by cleaning it with dry steam in a specially barricaded area.

Fig. 3 — Thermally Circulated Loop Apparatus



DYNAMIC CORROSION LOOP

Dynamic Tests Simulate Service

Results from a special long-time static corrosion test are typical. Specimens of stainless steel Types 302, 304, 316, 321 and 347 did not change in weight and were unattacked visually and metallographically after one year in relatively pure sodium at 500° C. (932° F.). Many of the results of static corrosion tests have been reported in the "Liquid Metals Handbook" and *Metal Progress* Data Sheet for December 1950. It should be emphasized that these data apply only to equivalent service conditions.

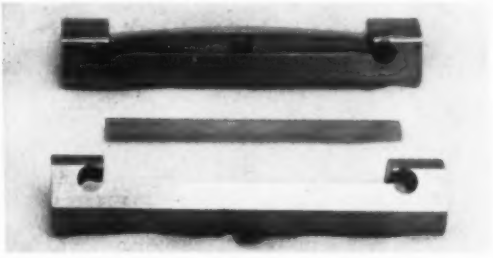
If the results of the static corrosion test are favorable, dynamic tests customarily follow to simulate more closely the conditions of service. Four types of dynamic tests are *(a)* rotating specimen (whirligig); *(b)* thermally circulated loops (harps); *(c)* forced-circulation loops; and *(d)* surveillance coupons in operating heat transfer systems.

ROTATING SPECIMEN TEST

In the rotating specimen test, a cylindrical specimen is whirled within a baffle assembly immersed in sodium (Fig. 2). Erosive conditions can be altered by adjusting the baffle clearance. Higher surface velocities are obtainable in the rotating specimen test than with most loops. The test is comparatively simple and inexpensive, and is convenient for studying the effects of impurities in sodium. Here, as in other tests, Type 347 stainless steel was not attacked by clean sodium at 932° F. However, the rate of attack increased markedly when the sodium was saturated with its oxide.

One of the principal limitations of this test is that it does not provide the tempera-

Fig. 4 — Stress-Corrosion Test Specimen and Fixture



Temperature Differentials

ture differential found in service applications. As would be expected, the solubility of most metals in sodium increases with temperature. With a test operated at constant temperature, "corrosion" ceases when the sodium becomes saturated with the components of the material being tested.

In heat transfer systems with flowing sodium, much higher rates of attack may occur because of temperature differentials. Sodium can be saturated with iron, for instance, in the hottest part of a steel system, and then when it passes through a cooler zone, precipitate iron until it is saturated at the lower temperature. Thus, iron can be transported from a hot zone to a cold zone. Fortunately, with stainless steel and relatively pure sodium, the magnitude of this process has so far proved negligible.

To study the effect of temperature differentials, it is necessary to use thermally circulated or forced-circulation loops. The thermally circulated apparatus (Fig. 3) consists of a harp-shaped loop of pipe with necessary connections for filling and gas blanketing. Heating the vertical leg and cooling the upper horizontal section of the loop circulates the sodium. Forced-circulation loops are similar except that a mechanical or electromagnetic pump is used to drive the sodium around the loop. These tests are especially useful for studying mass transfer by observing the difference in weight change between specimens in the heated and cooled zones. Both tests are relatively expensive and complicated. As a rule, these tests are used as a final check before the materials are approved for specific applications. With sodium of nominal purity, Type 347 stainless steel specimens in both types of test exhibited insignificant weight gains and appeared unattacked under the microscope.

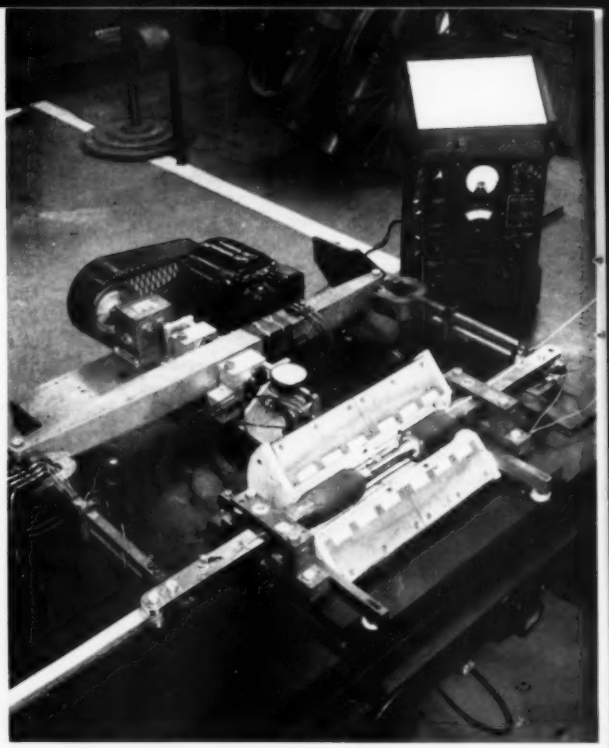
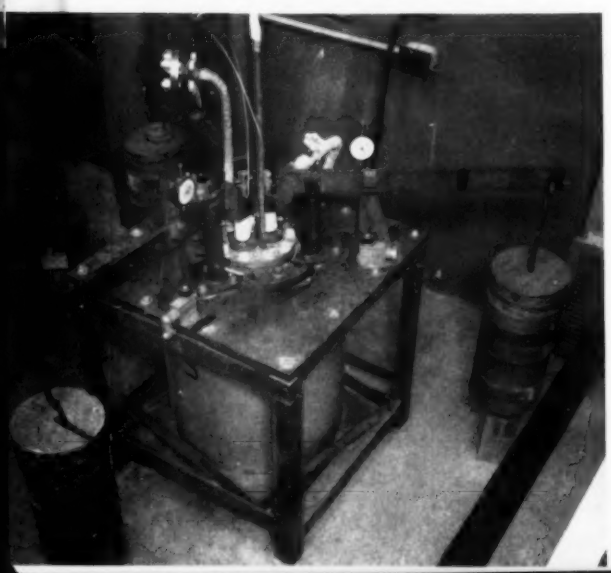


Fig. 6 — Slow Fatigue Apparatus With Specimen Mounted for Test in Air

Fig. 5 — Stress-Rupture Test in Operation, Showing Furnace and Method of Loading



After a sodium heat transfer system is built, the progress of corrosion is followed as it is in chemical plant systems by the periodic removal of surveillance coupons placed in the system where conditions are expected to be severe. In addition to providing design data for subsequent systems, the surveillance test serves to protect the system by giving advance notice of hazardous corrosion damage. The results from surveillance specimens have so far agreed well with those from dynamic corrosion tests.

None of the tests described reveal the

effect of sodium on mechanical properties, but are limited to determining changes in appearance, weight, thickness, and microstructure. Four methods of determining the effect of sodium immersion on mechanical properties are in use. The simplest and most easily performed is the stress-corrosion test, using small beams bent in a fixture with a constant deflection, usually beyond the yield point (Fig. 4). A number of such assemblies can be run in a static corrosion vessel. Stress-corrosion is revealed by microscopic examination of the specimen. The following types of stainless steel and other alloys have been tested without a single indication of susceptibility to stress-corrosion in sodium at 932° F.: stainless Types 304 ELC, 304, 310, 316 and 347; nickel; 80 Ni, 14 Cr, 6 Fe; and 67 Ni, 30 Cu.

The second and more informative method is the stress-rupture test in sodium. Figure 5 shows an assembly of the general design of Fig. 1 in a heating furnace. The top flange of the sample container has three openings leading into perforated tubes, each of which encloses a test specimen. The specimen itself is held in grips; the lower grip is fixed against the container lid and the upper grip is attached to the loading levers through a suitable gastight sleeve. A comparison of curves for stress versus time to rupture or elongation versus time, in air and in sodium, indicates the effect of the exposure quantitatively. Because stress-rupture properties vary widely with each heat of a given material, only data for the same lot or the same bar of metal can be compared. Immersion in sodium at 538° C. (1000° F.) has had no effect on the stress-rupture life of Types 304 and 347 stainless.

A third method of determining the effect of sodium on mechanical properties is to run a tensile test on wires before and after a standard static corrosion test. The sensitivity of this method is a function of the wire diameter. For example, an attack of one mil reduces the cross-sectional area of a 15-mil wire by 25%, a sufficiently large reduction to affect tensile strength. Wires of Type 347 stainless steel 15 mils in diameter were as strong, both at room temperature and 1000° F., after immersion for five

Effects on Mechanical Properties

months in sodium at 932° F. as they were after being similarly heated in a sealed can filled with helium.

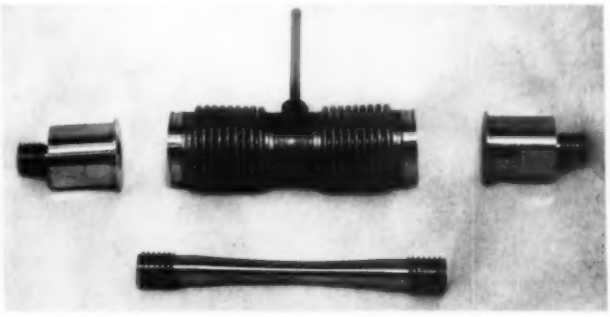
Fourth on the list of methods is the slow fatigue test (Fig. 6), in which a test bar is bent slowly beyond the yield point and then slowly straightened. After fatigue data are obtained in air, the test is repeated with the specimens immersed in sodium (Fig. 7). No shortening of the fatigue life of Type 347 stainless steel has been observed in any of several tests in sodium.

ADVANTAGES IN A HEAT TRANSFER SYSTEM

When sodium is used in a heat transfer system, its treatment to prevent corrosion before and during operation is relatively simple as compared with the treatment required for boiler feed water. In filling a system with sodium, the only purification required is a simple filtering operation to remove solid impurities. To maintain this purity during operation, it is necessary only to exclude air from the system by an inert gas blanket. On the other hand, in a typical steam plant, boiler feed water is demineralized and de-aerated; then during operation caustic is added to keep the boiler water alkaline, phosphate to keep it soft, sulphite to combine with dissolved oxygen from the condensate; and finally, some boiler water has to be discharged periodically (blowdown) to prevent an excessive buildup of solids in the boiler.

It is fortunate that a coolant as noncorrosive as sodium is available to accelerate the progress of nuclear power.

Fig. 7 — Slow Fatigue Specimen and Bellows Used to Hold Sodium



By Harold J. Roast, Consulting Editor to Metal Progress on Foundry Problems

An Unusual Tin Bronze Casting

RECENTLY a visit was paid to the Baldwin-Lima-Hamilton Corp., at Eddystone, Pa., to inspect facilities for the casting of a large tin bronze pump casing. This corporation is one of the Baldwin group, builders of locomotives, both steam and diesel, heavy hydraulic machinery, testing equipment and other diversified machinery essential to defense production.

Through the courtesy of George Walsh and M. K. Wright, members of the sales promotion department, the writer was conducted through the huge office building to B. A. Miller, superintendent of foundries. Here he met the various personnel directly responsible for the production of the large casting in question.

One is impressed with the stature of the Baldwin plant even before entering. When the writer telephoned the office to inquire how to reach the plant, he was told to "get off at Baldwin station; it's right in the middle of our plant". The fact that the plant has a railway station of its own prepared the visitor to some extent for what lay in store. Some 8000 workers are employed in various well-separated buildings, each as large as a notable factory. The office building is a towering central structure, so that although you know the person you want to see is in it somewhere, you are glad to be taken in charge.

Before inspecting the details of the casting manufacture, the writer went into the foundry proper. Space was the first impression — and no wonder, seeing that the length of the foundry is some 900 ft., the width 250 ft., and the peak height 75 ft.

In due course we arrived at the oil-fired reverberatory furnace in which the tin bronze for the pump casing had been melted. One feature of this furnace is the lack of an obvious stack to carry off the smoke, but it was pointed out that the gases are taken in a flue *below* the floor to the main stack. Another feature is the temperature control, effected by Marshall thermocouple tips in each of the four walls. These are connected to a Brown recording potentiometer. Tests have established the relation between the temperature of the walls and of the molten metal.

The metal used for the large centrifugal pump casing shown in Fig. 1 was composition ingot analyzing 90% copper, 8% tin, and 2% lead; the amount melted was some 30,000 lb. The reverberatory furnace was charged at 7:30 a.m. and the metal tapped at 11:40, thus taking only 4 hr. to melt. No oxidizing flux was used in the furnace, but 2 oz. of 15% phosphor-copper per 100 lb. of metal was placed in the ladles before filling — this for deoxidizing purposes. Tapping temperature for this alloy was 2280 and pouring temperature 2160° F.

The mold was made of silica sand, grain size No. 44, bonded with 12% portland cement, and 6.5% water. The setting time was 72 hr., but after 24 hr. a suitable blackening "Mineralcote" was applied to give the casting a smoother skin. Cast iron chills 2 in. thick were placed in the drag to control local cooling rates.

Provision was made for seven risers, requiring, all told, 8000 lb. of molten metal. Gypsum insulating sleeves were used with the risers and gypsum powder to cover the tops after pouring so as to prolong the cooling period.

Most of the cores were made of cement-bonded sand. Oil-bonded sand was used in places where a softer core was indicated. The large cores had cinder filling to aid the escape of gas and subsequent removal.

Two molders and two helpers made the mold and eight men helped in the pouring. The casting was poured "two up" through two of the risers, two runner boxes being used. There were no stoppers in the runner boxes. Four hours after pouring, the mold was released around the critical areas to avoid shrinkage cracking; when the casting was removed at the end of 48 hr. it was still uncomfortably hot.

The casting was cleaned by hydrostatic pressure of 400 psi., and was proof tested at 80 psi. A test bar attached to the casting showed a yield strength of 20,000 psi.; tensile strength, 39,500 psi.; and elongation 32% in 2 in.

Cooperation Speeds Delivery

Speed was of the essence in this job. The casting was poured on Wednesday, shipped to Ingersoll-Rand Corp. on Friday, and by the following Friday it had been machined and sent on to the customer, Standard Oil Co. of New Jersey.

This casting constituted the base of a centrifugal pump casing destined for oil refinery service. It was 9 ft. 9 in. long from inlet to outlet. Inlet was 36 in. inside diameter, outlet 30 in. The shipping weight was 20,000 lb.

While this casting is one of the largest ever made of a tin bronze alloy, much larger ones of different composition have been produced in the Baldwin foundry. Components requiring 100,000 lb. of metal have been cast from both ferrous and non-

Fig. 1 — Feeding-Up to Replace Shrinkage as a Huge Manganese Bronze Ship's Propeller Cools

Fig. 2 — This 20,000-Lb. Pump Casing Is One of the Largest Tin Bronze Castings Ever Made

ferrous alloys. A good example is the ship's propeller cast in manganese bronze, referred to on page 77.

In retrospect, this visit to one of America's leading factories for heavy machinery remains in mind as a notable example of friendly and efficient cooperation which must be the despair of totalitarian dictatorship. The problems of management, planning, supply, and staff that are involved in the successful and speedy production of such an item as this pump casing are very great, in all conscience. But when the visitor views the entire manufacturing area from a vantage point high in the office tower and realizes that each building houses not one but many enterprises, equally intricate, the conclusion is inescapable that only by free exercise of initiative on all levels could such marvels be accomplished.

Correspondence

Selling Research to Management

BOSTON

As Chairman of the Pressure Vessel Research Committee of the Welding Research Council, I wish to commend very highly the article in the January issue of *Metal Progress* by Mr. Cyril Stanley Smith entitled "Pure and Applied Science in American Metallurgy".

We in the Pressure Vessel Research Committee have the same problem in convincing hard-boiled vice-presidents of our contributing organizations that the research we conduct has sufficient dollar value and therefore justifies the continuation of their contributions.

A difficulty arises when our published reports are evaluated by technical experts below the status of those executives who must decide whether the contributions will be continued and how much they shall be. We must, therefore, depend upon a relationship between the technical men and their superiors (who have neither the time nor inclination to read our reports). Unless the inferiors can convince the superiors, we must print and circulate specially condensed and convincing reports, and hope they will be read and comprehended by the executives.

Our thesis is that fundamental research common to a given industry can more economically be conducted at less total cost and with least duplication of effort by a cooperative agency. It is our experience that such agency cannot depend upon individual suggestions from contributors, but must itself formulate the general policy for research and organize the individual projects to carry out the broad policy. Consequently, the agency must plan so that the individual supporters will not only understand but encourage such planned policy.

With a limited budget for cooperative research and limited capacity in our university laboratories, due to the abnormal demand by Government agencies, our schedule of projects must be planned over a three to five-year period.

Since we must depend upon dollar value to obtain dollar support, we must compromise between purely fundamental research with no immediate promise of application, and direct applied research applicable to a single product or design. We believe the latter is the function of the individual company's research laboratories.

The Pressure Vessel Research Committee is investigating at present time the significance of concentrated stresses in pressure vessels and especially the change in conditions which would result from the use of high-tensile low-alloy steels. This is a new field in which there is little background of experience. We cannot wait for such experience but must rely upon research to indicate what will be safe. This is a great responsibility that must be carried out with limited funds and in a limited time.

In addition, we must demonstrate the dollar value each year to somewhat impatient vice-presidents who may not have the complete viewpoint of their comprehending and sympathetic subordinates. I wish such executives would read Dr. Smith's article from beginning to end.

PERRY R. CASSIDY
Executive Assistant
The Babcock & Wilcox Co.

Welded Monoframes

PITTSBURGH

We too have been concerned about the inadequacy of our nomenclature for the generic designation of a properly designed welded structure. In the Editor's opinion (footnote to Mr. Karnisky's review of "Progress in the Welding Industry" on p. 62 of the January 1952 issue) "monolithic" and "jointless" won't do, and "monometallic" and "unipartous" are just possible.

The term "jointless" should be generically correct, but would appear inaccurate in many of the designs wherein welds have constituted a minimum cross section in the design. However, even these are truly "jointless", but that word has a negative connotation. The term "monocoque" seems to be too closely associated with an airplane skin or similar covering.

The commonly applied designation "rigid" is inaccurate in this application. The most precisely descriptive name we have found related to the action of such structures is "solid-elastic".

We now have so many inaccurately defined words in our language that I would hesitate to add to that confusion, but a welded structure might be quite accurately described by the term "monoframe".

H. E. CABLE
District Manager
The Lincoln Electric Co.

Correspondence

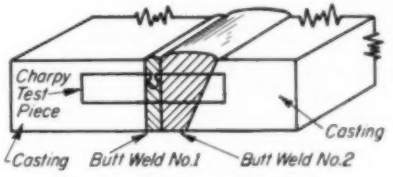
Course of Impact Fracture

SCHENECTADY, NEW YORK

In some impact tests made on composite bars in 1951, an interesting new phenomenon came to light, wherein the path of fracture was apparently influenced by the presence of tougher material in the immediate vicinity.

Charpy bars were prepared from a composite bar as illustrated. The casting consisted of extra low-carbon Type 316 stainless steel (18-12 Mo) which has an impact strength of about 80 ft-lb. in the annealed condition. Pad weld No. 1 was deposited on the flat edge of a plate cut from the casting; in one series of samples it consisted of Type 312 (29 Cr, 9 Ni) weld deposit, and in another series of Type 347 (18-10 Cb) weld deposit. This layer, in which the keyhole was centered, was about $\frac{1}{8}$ in. wide. The large half-vee butt weld, No. 2, was then made with Type 347 electrode. After heat treating to produce embrittling sigma in the ferrite-bearing weld deposits, Charpy bars were cut and tested at room temperature.

The series of six bars in which the keyhole layer consisted of Type 312 deposit was rather brittle (about 2 ft-lb.) and the fracture occurred entirely within this layer, except for one bar in which the fracture path just touched the casting-weld interface. In the series of test bars in which the keyhole layer consisted of Type 347 weld deposit, however, the fracture path veered toward the casting side of the bar and included some of the



Sketch of Composite Bar and Position of Charpy Test Pieces

casting material in the fracture. This preferred direction toward the material with higher impact strength occurred in 11 out of the 12 bars wherein both welds No. 1 and 2 were made of Type 347. (The fracture path of the 12th bar was included completely within the weld; it had an impact strength

Correspondence

of 15 ft-lb.) The 347 layer, unlike the 312 layer, deformed considerably in the vicinity of the keyhole.

The reason why the fracture path veers toward the side having higher impact strength is not obvious, but does reflect the influence of the deformation and fracture properties of the material surrounding the keyhole area on the propagation of the fracture. Perhaps such composite specimens, consisting of a logical selection of metals of various impact strengths, could lead toward a better understanding of impact fractures.

L. H. Satz
Metallurgical Engineer
General Electric Co.
Schenectady Works Laboratory

Perchloric Acid Hazard

Copenhagen, Denmark

The question of risk when using perchloric acid in etching solutions continues to arise. It would be unfortunate if this very useful metallographic reagent were put on the black list, since Pierre A. Jacquet (the originator of its use in electropolishing) has concluded that mixtures of perchloric and acetic acids with less than 50% perchloric are not dangerous.

Walter R. Meyer* refers to the "mysterious" explosion in Los Angeles in 1944. It is known that the bath used there contained three parts of perchloric acid to one part acetic acid anhydride. This is a completely unjustifiable composition. Furthermore, the bath was in contact with Tenite 2 (cellulose acetobutyrate) which by trial has caused heavy explosions with concentrated, warm perchloric acid. Finally, the cooling system was out of order, but the work was continued even when the temperature of the bath steadily increased.

The present writer published a cautionary note in *Stahl und Eisen* in 1941 (p. 777), and now after 10 years of work with electropolishing it falls to my lot to warn against excessive fear of these solutions.

We use several electrolytes based on De Sy and Haemer's type (6% perchloric acid in alcohol) in a Danish apparatus. To all these we have added inert materials which prevent the concentration, by evaporation, of dangerous derivatives.

We have unsuccessfully tried to cause explosions in the following ways:

Blocks and thin plates of Bakelite (according to many warnings an especially dangerous material) have, for eight months, been constantly exposed to the attack of these electrolytes, partly by dipping and partly by washing. Each night they were dried in the open air. Then without removing the remaining electrolyte we tried to induce explosion by

1. Burning over a flame.
2. Rubbing with red-hot steel.
3. Lance-like flames from smokeless powder.
4. Exploding detonators for various types of ammunition.

None of these tests produced an explosion or even a decrepitation.

We have misused the baths by working at such an excess voltage that the liquid underneath came to the boil with a lively flow of sparks to the sample; the sample was in contact with a Bakelite plate which, in turn, was in touch with both steel and electrolyte, and the thin edge of the Bakelite was completely burned through by the sparks — but nothing else happened.

These so-called D.I.S.A. electrolytes have been in use for five years in laboratories all over the world without our receiving any reports of accidents. If the polishing apparatus is placed on a base of glass or stainless steel and wiped clean every day, it is possible to work with every electrolyte of the De Sy and Haemer type, with or without the special admixtures, without the slightest fear.

As a matter of principle I always advise people not to improvise admixtures to perchloric acid electrolytes if they are not skilled chemists. I also warn them against allowing the electrolyte to evaporate, although I consider the D.I.S.A. electrolytes to be completely harmless.

In short, it must be emphasized that ingredients of an explosive nature do not necessarily make a mixture in itself explosive; it can be 100% safe all the same. That such materials require to be treated with caution is obvious, but care is another thing.

E. Knuth-Winterfeldt,
Director of Science
Dansk Industri Syndikat

*The Editor's comment to Mr. Meyer's letter was largely devoted to a warning against the danger of perchloric acid which, through evaporation, had condensed on the inner surfaces of hoods or ventilating systems.

NICKEL-CHROMIUM MOLYBDENUM STEEL VALVE CASTING

Retains Stamina after 50,000 Hours at 900° F!

After exposure to steam at 900° F. for more than 6 years, a Lunkenheimer gate valve cast in nickel-chromium-molybdenum steel was made available for study through cooperation of The Detroit Edison Company.

Despite its long continuous service, examination of specimens taken at random, including sections of welds, revealed the following characteristics:

NO LOSS OF STRENGTH
NO EMBRITTLEMENT
NO OCCURRENCE OF GRAPHITE

This confirms extensive laboratory tests and provides convincing evidence that valves and fittings cast in nickel-chromium-molybdenum steel, conforming to requirements of grade WC-4, ASTM Specifications A-217, will adequately meet the severe conditions imposed by steam at high pressures and temperatures up to 900° F.

At present time, the bulk of the nickel produced is being diverted to defense. Through application to appropriate authorities, nickel is obtainable for the production of engineering alloy steels for many end uses in defense and defense supporting industries.

MANUFACTURED BY THE LUNKENHEIMER COMPANY, Cincinnati 14, Ohio, the valve selected for test was identical to the 4-in. gate valve shown above. Before removal for study, it served continuously for 53,810 hrs. at a nominal temperature of 900° F. and at an average pressure of 841 p.s.i.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

Typical Properties of Beryllium-Copper Alloys

Prepared by J. T. Richards
Development Engineer, The Beryllium Corp., Reading, Pa.

Alloy	Nominal Composition	Form (a)	Condition	Heat Treatment F.	Tensile Strength (b)		Yield Strength 0.2% Offset		Proportional Limit 0.002% Offset		Elongation in 2 In.		Rockwell Hardness (b)				Electrical Conductivity % I.A.C.S.		Uses
													B or C Scale		Superficial				
					Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	
25	1.90 Be 0.25 Co Bal. Cu	Strip	A	(c)	60	78	28	36	15	20	35	60	B-45	78	30-T-46	67	17	19	Springs, diaphragms, bellows, contacts, clips, cams, bearings, bushings, sealing and retaining rings, spring or wave washers, fasteners, terminals, solderless connectors, roller chains, safety tools, valve and pump parts, balance weights, flapper valves, solenoid plunger guides, high-frequency contact rings, grounding strips, flash welding dies and electrodes, clock and watch parts, aircraft engine components. **Specifications met by Alloy 25:** Strip: A.S.T.M. B194; A.M.S. 4630 and 4632; MIL-C-947 and -6942; QQ-C-533 Rod and Bar: A.S.T.M. B196; A.M.S. 4650; MIL-C-947 and -6941 Wire: A.S.T.M. B197; A.M.S. 4725; MIL-C-947 and -6941
			¼ H		75	88	60	80	40	60	10	30	B-68	90	30-T-62	75	16	18	
			½ H		85	100	75	90	55	70	5	15	B-88	96	30-T-74	79	15	17	
			H		100	120	95	112	70	85	2	7	B-96	102	30-T-79	83	15	17	
			A-T	3 hr. at 600	165	190	140	170	100	125	4	10	C-36	41	30-N-56	61	22	25	
			¼ H-T	2 hr. at 600	175	200	150	180	110	135	3	6	C-38	42	30-N-58	62	22	25	
			½ H-T	2 hr. at 600	185	205	160	190	120	145	2	5	C-39	42	30-N-59	63	22	25	
			H-T	2 hr. at 600	190	210	165	195	125	155	1	3	C-40	42	30-N-60	64	22	25	
		Rod	A		60	85	20	30	15	22	35	60	B-45	85			17	19	
			½ H		85	130	75	105	35	65	10	20	B-88	103			15	17	
			A-T	3 hr. at 600	165	185	145	175	100	125	4	10	C-35	41			22	25	
			½ H-T	2 hr. at 600	185	215	170	200	120	150	2	5	C-39	42			22	25	
		Wire	A		58	78	20	30	15	22	35	55					17	19	
			½ H		110	135	90	110	60	80	2	8					15	17	
			A-T	3 hr. at 600	165	190	145	175	110	135	3	8					22	25	
			½ H-T	2 hr. at 600	190	230	185	220	135	165	1	3					22	25	
			PT		145	205	130	195	95	140	1	3					21	23	
165	1.70 Be 0.25 Co Bal. Cu	Strip	A-M		100	115	85	100	55	75	18	22	C-18	23	30-N-37	42	28	33	Springs, miniature tube sockets, connectors, terminals, fuse clips.
			¼ H-M		110	125	100	110	75	90	15	19	C-21	26	30-N-42	47	28	33	
			½ H-M		120	135	110	125	85	100	12	16	C-25	30	30-N-46	51	28	33	
			H-M		135	150	125	140	95	110	9	13	C-30	35	30-N-50	55	28	33	
10	0.5 Be 2.5 Co Bal. Cu	Strip	A		38	55	20	30	10	20	20	35	B-20	45	30-T-29	45	25	30	Current-carrying springs, switch parts, socket contacts, aircraft valve guides, flexible connectors, circuit breaker parts.
			H		70	85	60	80	40	60	5	8	B-70	80	30-T-69	75	22	27	
			A-T	3 hr. at 900	100	120	80	100	55	75	8	15	B-92	100	30-T-77	82	48	52	
			H-T	2 hr. at 900	110	130	105	120	75	95	5	12	B-95	102	30-T-79	83	48	52	
		Rod	A		38	55	20	30	10	20	20	35	B-20	45			25	30	
			½ H		60	80	55	75	35	65	10	15	B-60	75			22	27	
			A-T	3 hr. at 900	100	120	80	100	55	75	10	25	B-92	100			48	60	
			½ H-T	2 hr. at 900	110	130	100	120	70	90	8	20	B-95	102			48	60	
50	0.4 Be 1.5 Co 1.0 Ag Bal. Cu	Rod	A		38	55	20	30	10	20	20	35	B-20	45			25	30	Spot, flash, seam and projection welding dies and electrodes.
			½ H		60	80	55	75	35	65	10	15	B-60	75			22	27	
			A-T	3 hr. at 900	100	120	80	100	55	75	10	25	B-92	100			50	52	
			½ H-T	2 hr. at 900	110	130	100	120	70	90	8	20	B-95	102			50	52	
20C	2.0 Be 0.5 Co Bal. Cu	Cast	C		70	85	40	50	20	30	15	30	B-75	85			17	22	Cams, bushings, scraper blades, bearings, gears, valve and pump parts, safety tools.
			A		60	70	20	40	8	15	30	45	B-65	75			14	18	
			A-T	3 hr. at 650	150	175	115	155	105	125	1	3	C-38	45			20	25	
275C	2.7 Be 0.5 Co Bal. Cu	Cast	C		90	105	50	60	40	50	15	25	B-80	90			17	22	Plastic molds by sand, pressure and investment techniques.
			A		80	90	20	40	15	25	15	20	B-80	90			10	16	
			A-T	3 hr. at 650	140	165	110	130	85	105	1	2	C-42	48			18	23	
10C	0.6 Be 2.5 Co Bal. Cu	Cast	C		45	55	15	25	10	20	17	25	B-48	55			32	38	Heavy current-carrying springs, circuit breaker and switch gear parts.
			A		40	50	8	15	6	12	25	30	B-30	40			20	24	
			A-T	3 hr. at 900	100	120	55	70	45	70	5	12	B-92	103			45	50	
50C	0.4 Be 1.5 Co 1.1 Ag	Cast	C		40	55	15	25	10	20	27	33	B-45	55			32	38	Spot, flash, seam and projection welding dies and electrodes.
			A		40	50	10	18	8	15	25	40	B-30	45			20	24	
			A-T	3 hr. at 900	95	110	65	85	50	65	5	10	B-92	100			48	53	

Symbols: A Solution annealed; ¼ H Quarter-hard (1 No.); ½ H Half-hard (2 No.); H Hard (4 No.); T In suffix indicates "heat treated"; M In suffix indicates "mill hardened"; PT Pretempered; C As cast

Notes: Special property combinations including higher elongation and conductivity obtainable through special heat treatments.

Modulus of elasticity, approximately 18,000,000 to 19,000,000 psi.

Coefficient of thermal expansion, 0.000009 in. per in. per °F.

Density, approximately 0.30 lb. per cu.in.

(a) Properties vary slightly with diameter or thickness.

(b) Figures for tensile strength, yield, and proportional limit are in 1000 psi. Low tensile strength and hardness figure of range (excepting Condition A) is specification minimum. For Condition A, high figure is specification maximum. Certain size limits apply for hardness tests.

(c) Alloy 25 is not supplied in the heat treated condition. Properties quoted are typical for parts hardened after fabricating at time and temperature indicated.

STAINLESS STEEL FOR SUBSTITUTIONS

If your production is threatened by the short supply of critical materials stainless steel may be your answer. Several types of stainless steel are in good supply, and are competitive in price with other materials. Latest N. P. A. directives have made certain types of stainless steels obtainable without restrictions.

Our engineering department will be glad to consult with you to see if you can fabricate stainless with your existing tools. You may choose to save money by using lighter gauge material and take advantage of the superior strength of stainless.

For complete technical information and advice, contact the Sharon district office nearest you, or write direct to Sharon Steel Corporation, Sharon, Pennsylvania.

SHARONSTEEL

SHARON STEEL CORPORATION

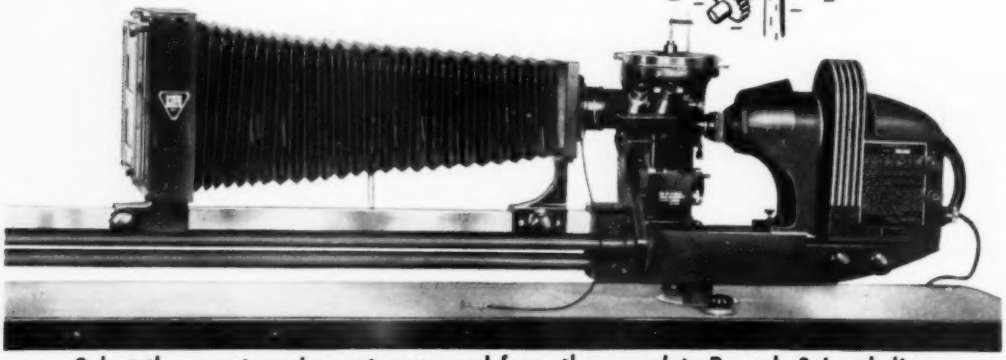
Sharon, Pennsylvania

BOOST PRODUCTION...

One important key to higher production is improved laboratory control with the world's finest metallographic instruments . . . Bausch & Lomb!

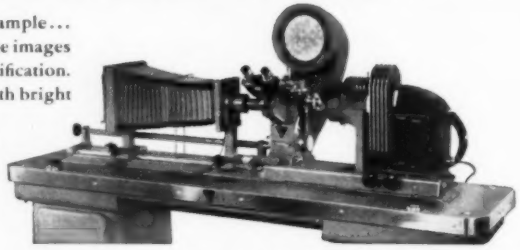
FROM LADLE

TO FINISHED PRODUCT

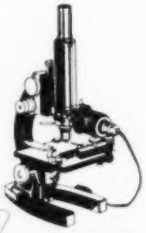


Select the *exact* equipment you need from the *complete* Bausch & Lomb line.

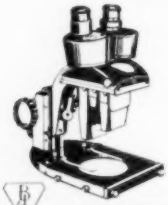
RESEARCH METALLOGRAPH—*See* the sample... *photograph* it . . . *four* ways! Four different accurate images of the same sample, for more complete identification. Exclusive, patented B&L features permit critical work with bright field, dark field or polarized light . . . with quick, easy change-over. For phase contrast work B&L accessories are simply, speedily attached. The "maximum use" instrument for visual observation and photomicrography. Catalog E-240.



PHOTOMICROGRAPHIC EQUIPMENT MODEL L—With proper accessories *this one unit* provides visual microscopy, high and low power photomicrography, as well as photocopying. Catalog E-210.



CM METALLURGICAL MICROSCOPE—For examination of opaque objects, polished metal specimens, similar materials. Catalog E-223. Tri-Vert Illuminator (optional) provides bright field, dark field, or polarized light. Catalog D-108.



STEREOSCOPIC WIDE FIELD MICROSCOPES—Invaluable in preparation of polished metal specimens, study of fractures, porosity, macro-etched specimens and other low power metallurgical studies. Catalog D-15.

BALPHOT METALLOGRAPH—An economical instrument offering many advantages of highest priced metallographs. Permits work with bright field, dark field, or polarized light, and phase contrast. Quick-action stage elevating device eliminates coarse adjustment. Bright, magnified screen images . . . ideal for grain size determinations and group viewing. Catalog E-232.

WRITE for complete information to Bausch & Lomb Optical Co., 638-15 St. Paul St., Rochester 2, N. Y.

Bausch & Lomb *Metallurgical* Equipment

Turbine Blades, "Sweat Cooled"

Bethlehem, Pa.

In "Critical Points" in February 1951 *Metal Progress*, the Editor commented on the bottleneck in jet engine performance — namely, the rotor blade which is swept by hot gases. Three possible methods of making a more satisfactory blade are: First, a more refractory material; second, a hollow blade cooled by interior circulation; third, a porous blade, "sweat cooled".

The Editor's remarks indicate that the limits have been reached in the first solution; bull strength and awkwardness no longer get us any further; likewise we find ourselves in a situation where there simply is not enough cobalt and columbium to make the millions of blades we require.

How about the second possibility? Internal cooling is only a palliative. Large volumes of coolants would be necessary, it is difficult to circulate it effectively in such a part as a rapidly rotating turbine disk, and the full heat of the hot gases comes on the outer surface, in any event.

The third alternative, sweat cooling, offers much more hope. Since my brother and I have pioneered in the application of the principle in other fields — our first patent was issued in 1940 — it may be of interest to recount its chief features:

We envisage a turbine blade of air foil section, with hollow center, made of permeable metal. Through its center extends a bolt fastening the blade to the disk, tightened so that the blade itself carries a considerable imposed compressive stress, even when the disk is rotating at high speed. A gaseous coolant passes from the disk, out around the bolt in the bolt-hole's clearance, and percolates through the blade's wall. This out-sweep of cooling gas keeps the bolt at moderate temperature; consequently conventional bolting alloys with low relaxation rates are quite suitable. With very moderate flow of cooling fluid (foggy air would be excellent) the permeable surface is kept at acceptably low temperatures because the hot turbine gases are actually blown away — kept from physical contact with the blade's surface.

Such a construction could be made with the very minimum of critical alloys, because high-temperature strength, high stress-rupture stress, highest oxidation resistance, and high melting point would no longer be required of the porous material constituting the hollow air foil section of the blade.

George Atwell Richardson
Consultant

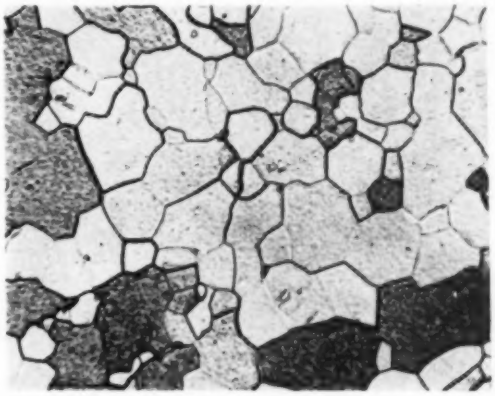
Polishing Tantalum

North Chicago, Ill.

The excellent cold workability and resistance to corrosion of tantalum is well known. However, these characteristics render it difficult to obtain an undistorted surface by manual polishing and to secure strong preferential chemical etching.

Our laboratory evaluated several methods of electropolishing and electro-etching and found the following method the most promising:

Solution:
90 cc. concentrated sulphuric acid
10 cc. concentrated (48%) hydrofluoric acid
(This solution is a modification of U. S. Patent No. 2,466,095.)
Cathode: Graphite or platinum
Temperature:
(with agitation) 35 to 45° C. (95 to 113° F.)
Electropolishing: Current density of 0.10 amp. per sq.cm. for 9 min.
Electro-etching: Current density of 0.02 amp. per sq.cm. for 10 min.



The accompanying micrograph shows the excellence of this method in preparing tantalum for microscopic examination.

G. W. Wensch
K. B. Bruckart
M. Conolly
Fansteel Metallurgical Corp.

By Herbert H. Uhlig, Corrosion Laboratory, Department of Metallurgy
Massachusetts Institute of Technology, Cambridge, Mass.

Trends in Corrosion Control

THE SCIENCE of metals and the science of corrosion both developed rapidly as metals came into large-scale use at the turn of the century. By 1900 consumption of steel in this country reached 10 million tons per year, with metal structures of all kinds exposed to the atmosphere, canal locks and cables submerged in water, steel boilers subjected to high-temperature steam, and miles of pipe line buried in the soil. The fact was gradually pressed home that corrosion, unless thwarted, slowly but inevitably was undoing all that was being accomplished.

For a long time this situation was accepted, and the impression gained ground that corrosion, like the weather, was something to be talked about but nothing could be done about it. Other than painting surfaces whenever possible, it seemed easier to replace metal structures than to find out what corrosion was, what caused it, and how it might be avoided. Only a few engineers in this period associated corrosion with anything other than iron's rusting, or perhaps the bright green patina on copper roofs. They were far from realizing that the occasional unfortunate boiler explosion, the sudden cracking of a ship's propeller shaft, were other forms of the same thing. Today, however, in many laboratories, offices and industries, the words "corrosion prevention" have graduated from a term unappreciated, misunderstood or irrelevant, to one connoting economic enterprise, scientific and engineering awareness, and conservation of the nation's resources. It is a subject that can no longer be ignored without grave economic and engineering risks.

In 1903 W. R. Whitney published a paper on the electrochemical theory of corrosion in the *Journal* of the American Chemical Society, Vol. 25, p. 394. This contribution did much to revive active scientific interest in the phenomenon, first studied by Sir Humphrey Davy, Michael Faraday, and W. H. Wollaston in England, and by A. de La Rive in France. Systematic accumulation of the scientific and engineering knowledge necessary to reduce some of the costs and hazards of corrosion soon followed. Practical interest increased as labor costs mounted, metals became less readily available, ore reserves threatened depletion, and demands were made for efficient and safe operation of machinery and transportation equipment. In addition, the new field of chemical engineering was setting unheard-of requirements for metals. Many chemical processes were suited to large-scale installations only after appropriate metals could be found, and some processes had to be shelved, at least temporarily, because the right alloy was not available. A most spectacular example came during World War II when the entire atomic fission program hinged on the successful solution of several corrosion problems. Other examples pointed up our need for more fundamental knowledge. An accelerated effort was therefore initiated after the war, particularly by the Armed Services, toward a better understanding of the chemical and electrochemical processes which change metals from ductile, strong solids to crumbling powders, or which send a sudden crack through an otherwise healthy cross section of some vital metal structure.

SUPERSTITION AND SCIENCE

Ignorance and witchcraft plagued the subject and retarded progress — perhaps an understandable situation where facts and theories are delayed because it takes time to corrode a metal under service conditions. As in the field of boiler-water treatment, which similarly suffers from lack of rapid evaluation techniques, the charlatans and the misguided dabblers have had rich pickings over the past 50 years. Corrosion control devices or formulations continue on the market today, sometimes proposed in all sincerity, but accomplishing only a few of the claims made for them. These proprietary devices blend into still others that are wholly and plainly false, promoted with the beat of the medicine man's tom-tom and the bark of

the snake-oil vendor, with claims couched in scientific jargon. The continued sale of these gadgets and formulas only proves that Barnum was right, and, more important, that scientific illiteracy among plant engineers and purchasing agents exists on an amazing scale. Perhaps this situation constitutes one of the strongest arguments that colleges and universities should school their graduating engineers in the rudiments of corrosion, paralleling present instruction in mechanical properties of metals. Unfortunately, adequate courses are available today at less than a dozen universities or technical schools in the country.

Bona fide scientific and technical advances, although slow in coming, have nevertheless made some real gains in combating a national loss now amounting to more than six billion dollars per year. (This is the cost of replacing corroded metals and of controlling corrosion wherever it exists.) Without these advances, the cost would be still higher and would probably have discouraged many technical accomplishments taken for granted today. A few examples illustrate this point.

Shortly after the appearance of Whitney's paper, W. H. Walker and his associates made a scientific study of the influence of dissolved oxygen in water on the corrosion of steel. This clarified the foggy notions then existing, and laid the foundations of modern boiler-water treatment. Further developments along these lines were necessary before high-pressure steam could be economically produced in steel boilers, and this, in turn, gave us cheap electrical power. Corrosion control was an essential step.

A second example is cathodic protection, first discovered in the laboratory of Sir Humphrey Davy around 1825, and adopted to protect the copper sheathing of British ships. The method was first used in this country around 1910 to protect buried structures. Today, cathodic protection has been installed on thousands of miles of pipe line and has become a major business. It was an important step toward low-cost distribution of oil and gas.

The present wide application of steel for fencing and roofs depended upon a protective coating, produced by dipping steel into molten zinc. The longer life of galvanized steel "sold" the farmer. Later, an addition of a few tenths per cent of copper was found to increase the life of uncoated steel in railroad and mining equipment, bridges, and other structures continuously exposed to the atmosphere. Then inhibitors came into use to prolong the life of water-cooling systems and tanks. The stainless steels arrived in the early 1920's, and were popularly utilized as architectural and automotive trim, and by the chemical industry for process equipment. Without such alloys, the fast-moving chemical industry would have been seriously

Fig. 1 — On This Ponderous Loom, Galvanized Fencing Is Woven for the Farms and Ranches of the Country. (Courtesy Colorado Fuel and Iron Co.)

Tests Evaluate Alloys

handicapped. Paints emerged from hocus-pocus mixtures giving indifferent results, to formulations scientifically designed for protecting metals; for the first time in the history of this old industry, science and technology had got by the front door. In this same period, measured by relatively few years, scientific treatment of potable and industrial waters to reduce corrosion was introduced using small amounts of lime, soda, phosphates and silicates.

THE CURRENT STATUS, IN BRIEF

All in all, the savings, direct or indirect, in labor, steel, oil, gas and water alone by present practices play a significant role in supporting our current industrial economy. Although direct losses are subject to an educated guess, indirect losses are much more difficult to appraise. Yet, indirect losses often exceed direct losses, as illustrated by a corroded natural gas line which lost 90% of its gas in 40 miles.

Metals and Alloys It is a fundamental tenet that all commonly used irons and steels, including low-alloy steels, corrode at approximately the same rate when totally immersed in the usual natural waters. This was proved as long ago as 1924 by laboratory experiments showing that the rate in soft waters is determined by dissolved oxygen content, and not by small changes in metal composition. Service data are in line with this conclusion. Also explained by these experiments is the observation that microstructure, residual stresses, and heat treatment of steel have no effect on rate of attack by most natural waters. The tests also settled a vigorous controversy that started more than 40 years ago and still crops up today as to whether steel, pure iron, ancient iron and wrought iron in fresh or in sea waters corrode at the same rate. They all do. Since exposure to various soils approximates conditions of total immersion in water, the same conclusions hold, by and large, for buried structures.

However, waters in the acid range below pH-4 to 6 cause corrosion which is accompanied by hydrogen evolution, whereupon dissolved oxygen alone no longer determines the amount of iron reacting. Composition, stresses and heat treatment may now have an effect. Therefore, steam return lines, carrying what is essentially hot dilute carbonic acid, should be carefully chosen for maximum resistance, but all kinds of iron or steel are about equally durable for a canal gate, or for sea-water piling.

Some data have been assembled from exposures in river and sea waters showing that a 3% chromium steel corrodes with fewer deep pits than other low-alloy steels, but the over-all weight loss is the same, and the advantage is usually overbalanced by the increased cost. Gray cast iron in natural waters and in the soil fails by so-called graphitic corrosion, whereby the ferrite constituent is attacked, leaving behind some compounds that cement together the residual graphite flakes. The affected iron, therefore, may have the same shape as the original but lacks strength and ductility. For example, cast iron pipes often continue to serve their purpose, even though corrosion may have

Fig. 2 — The Salt Spray Test Provides a Modern Scientific Method of Determining Behavior of Metals in Marine Environments. (Courtesy Aluminum Research Laboratories, Aluminum Co. of America)

Fig. 3 — Heavy Pipe Such as This for Transporting Natural Gas Long Distances Must Be Protected for Periods of Many Years Against Soil Corrosion. (Courtesy National Tube Co.)

progressed throughout the wall thickness.

The writer recently inspected the white cast iron uncovered at the first iron works at Saugus, Mass. After exposure to the elements and to the soil for a matter of 300 years, it corroded less than the expected 0.005 to 0.02 in. per year. A weighed sample has been reburied to check whether the low rate is typical of the metal, or is caused by some as-yet undiscovered factor. It is possible that cementite in a white cast iron is inherently more corrosion resistant than the mixture of ferrite and graphite in gray cast iron. (White cast iron, because of its limited utility, is seldom or never included in comparative service tests.)

As mentioned above, resistance of unpainted steels in the atmosphere is improved severalfold by a few tenths per cent of copper. The effect is greater if the steel has also high residual phosphorus. Copper-bearing steels form rust layers more adherent and protective than similar films on copper-free steels. Nickel in small amounts is similarly beneficial. These steels have no advantage in natural waters or in the soil, despite claims periodically made to the contrary.

Ferrous alloys containing at least 12% chromium define the stainless steels — so called, as everyone knows, because of their resistance to atmospheric rust or tarnish. The austenitic 18% chromium, 8% nickel varieties are the most popular compositions because of easy fabrication, and their corrosion resistance is somewhat better than the ferritic or martensitic types. These 18-8 alloys have proved wholly adequate for outdoor trim, as testified by the present appearance of the Chrysler and Empire State Buildings in New York City. National Bureau of Standards' exposure tests show that the 18-8's stand up well in various soils. However, they invariably evidence pitting in sea water within six months to one year. The molybdenum-containing composition (Type 316) is more resistant to pitting, but eventually corrodes in the same manner. All the stainless steels, therefore, are unsatisfactory for long-time sea-water immersion (unless cathodically protected* as explained later). Most of the standard Cr-Ni-Fe austenitic alloys are also susceptible to intergranular corrosion near weld zones in particularly heavy sections exposed to severe corrosive environments. The columbium-stabilized variety (Type 347) is resistant to this type of attack, but because of the present columbium shortage, it has been necessary to use more of the titanium-stabilized 18-8 (Type 321), which presents somewhat more difficult welding problems, and also the extra-low-carbon variety (ELC).

In sea water, relatively few metals can long withstand the ravages of corrosion without protection of some kind. Copper and copper-base alloys have good resistance and are relatively free from pitting and

*A stainless steel propeller on an ocean-going ship would normally pit in short order. However, because it is in metallic contact with a steel hull, the electric current set up by this combination protects the propeller and usually does relatively little damage to the hull. Revolving of the propeller also diminishes pitting.

fouling by marine organisms, but are not successfully applied if the liquid has high velocity. Hastelloy C (59% Ni, 17% Mo, 5% Fe, 14% Cr, 5% W) is one of the few alloys that has a good record when exposed for long periods to sea water. It seems from present data that titanium, although not resistant to fouling, is resistant to general attack, pitting corrosion and velocity effects. Having fairly high strength as well, it will probably find wide application in sea water.

Metal Coatings—Tin, zinc and nickel are the major metals used for protective coatings on steel. Tin-plate is ideally suited for food containers (tin cans). The nontoxic tin coating is more active electrochemically inside the can than the base steel, hence any electrolytic cells at the numerous pores in the coating send electric current in such direction that steel is protected from attack (again the principle of cathodic protection). Were it not for this, food containers would perforate by pitting in a relatively short time.

Zinc coatings also protect the underlying steel from rust by the principle of cathodic protection, and are effective for atmospheric, underwater and some soil exposures. Only within the last few years has it been demonstrated by laboratory experiments and confirmed by service data that zinc is not always protective. In contact with some hot waters above about 140° F., the zinc coating may become the positive instead of the negative pole of the electrolytic cell, and thereby accelerate pitting and failure of steel. This also suggests that blocks of zinc installed in boilers for internal protection have questionable value.

Nickel coatings are more noble than steel, and hence accelerate corrosion of the base metal at any pores in the coating. Therefore they must be thick enough to keep the number of pores to a minimum. For a reasonable service life before appearance of rust, this requires about 0.0005 in. for indoor exposures, and 0.0015 in. for outdoor. Nowadays, a thinner coating must often serve, because nickel is scarce. If nickel could be plated with fewer pores, the same or thinner coatings would give better protection. About 0.00001 in. of chromium plated over nickel will prevent tarnish or "fogging" by a thin film of basic nickel sulphate.

With clad coatings, a relatively thick overlay is metallurgically bonded to steel, and the result is equivalent to the resistance of the bulk metal. Some fabrication problems are encountered at the edges of such composite metals where steel is exposed, but these can usually be handled satisfactorily. Titanium-clad steel may find a good market when the price comes within range of present corrosion resistant alloys, because of the resistance of titanium to pitting in chloride solutions. (As yet, it cannot be electrodeposited as a protective coating.)

Sprayed metal coatings are inherently porous, and are best, therefore, when the coated metal is less noble than the base metal. A noteworthy advantage is that they can be applied to finished structures.

Paints and Nonmetallic Coatings—The most important consideration in painting is proper preparation of the metal surface. The formulation of paint, important though it is, is usually the lesser consideration in determining how much protection and for how long. Steel surfaces must be rigorously cleaned of oxide and grease. Oxide can be removed by sandblasting, flame cleaning, pickling, or wire brushing. The prime coat (the paint next to the metal) adheres adequately if applied immediately after cleaning and on a dry surface. Alternatively, some delay can be tolerated if the cleaned surface is phosphate-coated immediately by spraying or brushing on a dilute phosphoric acid solution containing zinc or manganese phosphates and reaction accelerants like copper salts. Pretreatment of this kind (called by trade names such as Bonderizing or Parkerizing) provides excellent adhesion of paints and minimizes undercutting at scratches or defects in the paint film.

The prime coats of modern paints contain a rust-inhibiting pigment, such as red lead or zinc chromate. These slightly soluble salts protect the steel to some extent against rusting by any water and oxygen which eventually diffuses through the top coats.

A development of World War II, called a wash primer, consists of a polyvinyl butyral resin vehicle and zinc chromate as pigment. An alcohol solution of phosphoric acid is added to the resin solution, which, like the phosphating treatment, insures a good paint-to-metal bond. One advantage is that the phosphate treatment and prime coat are combined in one operation. The wash primer also provides good adherence of paints to aluminum and to zinc.

Portland cement coatings have protected

iron in soft-water areas for 60 years or longer. Bituminous coatings are used frequently on buried metal. Also good for many purposes are enamel (glass) and thick plastic or rubber coatings.

Cathodic Protection is an efficient method of checking corrosion by utilizing electric current. It is particularly suited to protection of structures in contact with the soil, although useful in many other environments as well. An auxiliary supply of metal, easily replaced, is buried near the structure to be protected and is called the "ground bed" or "anode bed". The positive terminal of direct current is then connected to the anode, and the negative terminal to the structure to be protected. The current is regulated until it is just sufficient to overcome local-action currents accompanying the corrosion reaction on the surface of the structure, in accord with the usually accepted electrochemical mechanism. The current source may be a rectifier or a generator or a cast ingot of magnesium, which, like the zinc in a flashlight cell, sets up its own electric current as it reacts with its surroundings. Current requirements vary with conditions, but, in general, are on the order of about 0.0001 to 0.10 amp. per sq.ft. of steel surface. The required current often drops off with time as calcium carbonate or other natural protective coatings form. As long as the required current flows, the steel structure will not rust nor pit. It is not always appreciated that cathodic protection will mitigate other forms of corrosion such as pitting, intergranular corrosion, corrosion fatigue or stress-corrosion cracking.

The method is not useful for protecting against atmospheric corrosion nor reaction at elevated temperatures. Furthermore, pipes protected on the outside still corrode as usual on the inside. Here special provisions must be made such as placing a conforming wire or rod as anode the entire length of the pipe—not easily accomplished.

The Cathodic Principle

Organic coatings commonly supplement cathodic protection to reduce the required current and to localize it at unavoidable defects in the coating. In this way, one magnesium anode can protect as much as five miles of buried pipe line in some soils, whereas without it perhaps 10 to 100 ft. would be protected and no more. The cost of cathodic protection is almost always written off by savings in steel (use of thinner walled pipe) and savings of labor and product (insurance against failure, repairs and replacements). Typical installations are in protection of industrial and domestic water tanks, the steel gates at locks of the Panama Canal, most of the country's buried oil and gas lines and a considerable proportion of the cables that are buried or submerged.

TRENDS

The current trends in corrosion control may be listed:

1. Broader applications of cathodic protection. This means not only for buried structures and water tanks, but also for the mitigation of corrosion fatigue, stress-corrosion cracking, intergranular corrosion, and pitting wherever it occurs in any metal or alloy. One design accomplishes this by a

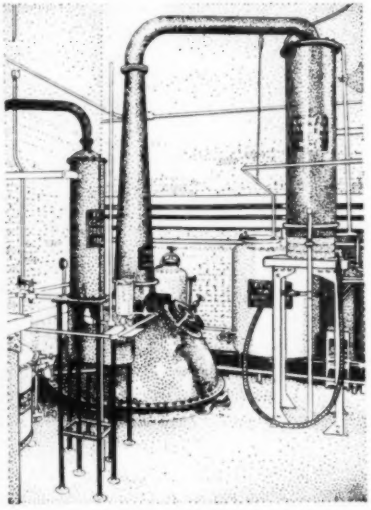
Fig. 4—Galvanized Sheets Are Inspected at Bethlehem Steel Co. Before Coiling

clad composite with the outside metal slightly more active electrochemically than the core. Duralumin clad with pure aluminum is an example; any corrosion cell set up at a break in the cladding serves cathodically to protect the core against general attack, as well as intergranular corrosion, stress-corrosion cracking and that part of fatigue damage caused by a corrosive environment.

2. More general application of corrosion resistant metals and alloys. The steady trend toward more severe conditions in the chemical and power industries has accentuated demands for better alloys. The acceptance of bright metal surfaces by architects and designers will continue to stimulate sales of aluminum, the stainless steels and related metals and alloys. Furthermore, many industries are discovering that the higher initial cost of these alloys is likely to be offset in short time by prolonged life and better performance.

3. Increased use of protective metal coatings. Major developments along these lines are still to come. When improved techniques for producing nonporous coatings are available, use of chromium and nickel coatings on steel, and also alloy coatings, will doubtless increase. For example, we can electrodeposit nickel-tungsten and iron-tungsten alloys with inherently excellent resistance to non-oxidizing acids. Plated coatings of these alloys (or others where molybdenum replaces tungsten) having adequate impermeability will be of considerable interest to the chemical industry. It is probable also that gas-phase reactions for producing corrosion resistant coatings will enjoy broader commercial interest; for example, stainless chromium-iron alloy surfaces can be produced by reacting steel with gaseous chromous chloride at 1600 to 1800° F.

4. More general use of inhibitors. This refers to inhibitors in pickling tanks, in cooling systems of engines and rectifiers, pistons and cylinders of internal combustion engines, steam boilers, air-conditioning equipment, oil wells, and pipes and machinery handling domestic and industrial waters. De-aeration processes (which remove dissolved oxygen, thereby making water noncorrosive to steel, copper, and brass) are an alternative when suitable inhibitors are not available or are not economical.



5. Broader use of paints, ceramics and plastics scientifically designed for optimum protection at both ordinary and elevated temperatures. Plastics of the tetrafluoroethylene type have remarkable resistance to all acids, alkalis, and organic solvents, as well as to most corrosive gases, and so are useful as linings and gaskets. Eventually, the outstanding stability of these and similar materials will be adapted to the protection of metals, particularly as adequate plastic-to-metal bonding agents are developed.

6. Increased employment of corrosion engineers by industry. In view of the fact that corrosion losses, even in relatively small industries, may amount to hundreds of thousands of dollars per year, this trend is not surprising. The present training of our corrosion engineers is at best perfunctory; usually it is self-acquired. Their background ranges from that of a mechanic, who operates entirely by empirical methods, to an engineer often brought face to face with his first corrosion problem by some critical urgency. More adequate training of men in this field is in order, and will undoubtedly come as industry makes its needs felt. The National Association of Corrosion Engineers, founded as recently as 1945 and already grown to 3000 members, is doing much to organize and promote the tremendous contributions that are possible in combating corrosion. Even if 1% of the present national loss were saved, this amounts to more than $600,000,000 per year. Any corrosion engineer worth his salt will volunteer to save at least 1% of losses in an industry now operating without benefit of expert advice, and will gladly split the difference on what is saved above this percentage.

Advertisement

ELECTROMET Data Sheet

A Digest of the Production, Properties, and Uses of Steels and Other Metals

Published by Electro Metallurgical Company, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. • In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

CHROMIUM...key metal for strength, corrosion resistance, and heat resistance

Chromium is one of the most important alloying elements in iron and steel metallurgy since it markedly improves certain chemical and physical properties.

Increases Strength

The strength of steels is greatly increased by chromium because it retards the transformation of certain constituents during rapid cooling.

This makes it possible to obtain great depth of hardness in high-carbon steels, toughness in structural steel, and high strength and ductility in heavy sections. Chromium also increases resistance to shock by refining the grain of the steel.

Of all the alloying elements, chromium is probably the least expensive for increasing the tensile strength of steel. Additions of as little as 0.25 to 1.25 per cent chromium will increase the chill and hardness

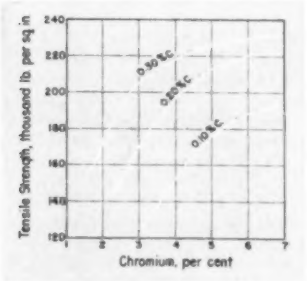


Fig. 1. Chromium increases the tensile strength of air-cooled steels of varying carbon content.

of the steel, as well as the tensile strength.

In copper, aluminum, and other nonferrous alloys, chromium provides increased strength, also.

Imparts Corrosion Resistance

Commercially, chromium is added to steel and iron in amounts up to 30 per cent for the purpose of improving corrosion resistance.

In general, as the chromium content is increased with a given carbon content, the resistance of the steel to corrosive media becomes greater. The well-known "stainless" steels resist corrosion because substantial percentages (usually 12 per cent or more) of chromium are present.

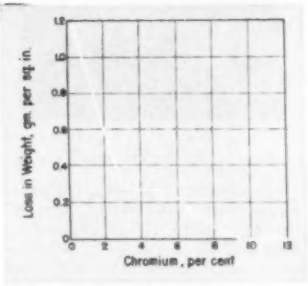


Fig. 2. Results of atmospheric corrosion tests on low-carbon steels of different chromium contents after 10 years of exposure to an industrial atmosphere.

Improves Heat Resistance

In both cast iron and steel, chromium provides good resistance to deterioration from heat. The use of chromium-alloyed iron and steel where high temperatures are encountered, for example, helps to prevent oxidation, which would ruin equipment. As little as 1 to 2 per cent chromium is added to cast iron to improve oxidation resistance and reduce growth of grate bars subject to high temperatures. Oxidation resistance improves progressively as the chromium is increased. Steels containing as little as 5 per cent chromium show good life at temperatures up to 1200 deg. F. For higher temperatures, appropriate steels of higher chromium content may be selected. Steels containing 25 to 28 per cent chromium give satisfactory service at temperatures up to 2100 deg. F.

Alloy cast irons with 15 to 30 per cent chromium are commonly used for applications requiring resistance to severe heat and abrasion.

In non-ferrous alloys, also, chromium is an important constituent for heat and corrosion resistance. It is used in the production of non-ferrous metal-cutting tools, chromium bronzes, and electrical resistance alloys.

Available Alloys

Chromium is produced by ELECTROMET in the forms listed below which are suitable for every use of the iron, steel, and nonferrous metal industry.

"EM," "Electromet," and "SM" are trade-marks of Union Carbide and Carbon Corporation.

Alloys of Chromium and Their Uses

Low-Carbon Ferrochrome	For production of corrosion- and heat-resistant steels, commonly known as the "stainless steels," as well as special high-temperature alloys in which a low carbon content is desirable.
High-Carbon Ferrochrome	For production of chromium-bearing steels that do not require low percentages of carbon. Also used for adding chromium to cast iron.
Nitrogen-Bearing Ferrochrome	For reducing grain size and improving physical properties of high-chromium steels.
"EM" Ferrochrome-Silicon	Used in the production of stainless steels for adding chromium to the bath, and for reducing oxidized metals in the slag back into the bath.
"EM" Ferrosilicon-Chrome	Readily soluble material for making either furnace or ladle additions of chromium to steels.
"SM" Ferrochrome	Readily soluble material for making chromium additions to steel or cast iron in either the furnace or the ladle.
Foundry Ferrochrome	Especially for use in making readily soluble ladle additions of chromium to improve composition and properties of cast iron.
Chromium Metal	For use in non-ferrous chromium-bearing alloys, such as electrical resistance alloys, high-temperature and corrosion-resistant alloys, metal-cutting tools, chromium bronzes, and certain high-strength aluminum alloys.
"EM" Chromium Briquets	For adding chromium to cast iron in the cupola.

Personal Mention

Marjorie R. Hyslop

It gives me pleasure to announce that MARJORIE R. HYSLOP, well known to members of the American Society for Metals as the gifted editor of *Metals Review* and Review of Metal Literature, has been given the added responsibility of managing editor of *Metal Progress*. BETTY BRYAN, another staff member, has been made associate editor of *Metals Review*, and will work under the general direction of Mrs. Hyslop. These moves are the beginning of a broad program of editorial expansion for *Metal Progress*, about which more will be said as it is achieved.

Mrs. Hyslop joined the American Society for Metals in 1930, shortly before the first issue of *Metal Progress* was published, a recent graduate of Ohio State University where she majored in metallurgy. For about 14 years she was secretary to the editor of *Metal Progress* and managing editor of *Metals Review*; then was assigned full time to *Metals Review* in 1944 when Review of Metal Literature was instituted. A major accomplishment of the latter years was the metallurgical literature classification jointly devised by the American Society for Metals and the Special Libraries Association an intricate project of which she was one of the originators and the executive secretary.

WM. H. EISENMAN
Secretary
American Society for Metals

H. H. Harris

MR. HARRIS ("Harry" to a great number of ASMembers) founded General Alloys Co. of Boston in 1919 and since then has continuously and vigorously promoted the manufacture and use of high alloy castings for severe service. Always interested in functional design, metallurgy and production technology of castings, he undertook in 1947 the direction of some nonprofit research and development projects for the Bureau of Ships and the Bureau of Aeronautics of the Navy with some striking results summarized in "Critical Points" in *Metal Progress* in July 1949. This work has been recommended, as has also a "Casting Potentials Project" for the Air Materiel Command, U.S.A.F., which Mr. Harris is also directing. The latter is a comprehensive effort embracing evaluation of process and applications, engineering design and pilot production of castings in all metals applicable to aircraft. Associate directors of the Casting Potentials Project are W. W. Edens (formerly technical director and superintendent of Ampco Metal, Inc., Milwaukee, and past chairman, A.S.M. and A.F.A. Milwaukee Chapters), and T. G. McNamara (formerly chief metallurgist of Continental Aviation and Engineering Corp., Detroit). Pilot production, utilizing Navy and company-owned facilities, is at Alloy Engineering & Casting Co., Champaign, Ill. The University of Illinois is also cooperating.

Francis C. Frary

FRANCIS C. FRARY ✪ has recently retired from many years of service as director of research for the Aluminum Co. of America. Although this will close his active career, he will continue to serve as technical advisor for the company. Dr. Frary founded organized research in the aluminum industry. Nationally known as a distinguished chemist and metallurgist before joining Alcoa in 1918, he established the Aluminum Research Laboratories at New Kensington, Pa., which, under his leadership, has become one of the world's foremost industrial metallurgical research institutions. Born in Minneapolis, he studied analytical chemistry at the University of Minnesota, receiving his M.S. degree there in 1906. He studied a year in Berlin, returning to the University as instructor and later as assistant professor, and earned his Ph.D. degree in 1912. In 1915 Dr. Frary devised a process for manufacturing the war gas phosgene, and helped to build and operate a huge plant for manufacturing this gas during World War I. He holds more than 30 patents and is author and co-author of numerous books and papers on metallurgical and chemical subjects. There is hardly a phase of today's aluminum industry that has not felt his influence. Among his honors are the Gold Medal of the American Society for Metals, the James Douglas Metallurgical Medal of the American Institute of Mining and Metallurgical Engineers, the Acheson Gold Medal of the Electrochemical Society, and the Pittsburgh Award of the American Chemical Society.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Revere began to make aluminum extruded shapes in 1922, and hence has had thirty years of experience with the metal. During those years it has gained invaluable experience, and has installed new equipment in order to expand the list of aluminum mill products it offers to industry. This expansion has been conducted at an accelerated pace during the past ten years. Today it may come as a surprise to some people that Revere's present installed capacity makes it the largest independent fabricator of aluminum in the United States.

Revere is sometimes asked why we should have sought the same position in aluminum alloys that we occupy in copper and copper-base alloys. The fundamental reason is a simple one: we wished to increase our service to industry, which is demanding more and more metals of every kind. Thirty years ago we recognized the growing importance of aluminum, and we also perceived that aluminum and copper are in many ways complementary metals. Being able to offer both means that Revere can be impartial in recommending the one most certain to give the best results in a given application.

So successful has been our experience with aluminum that we are now pursuing a comprehensive program of expansion in regard to it. In one of the Revere plants in Baltimore, new aluminum rolling mills and annealing furnaces were installed before Korea, making possible tripled production of coiled sheet. Right now, in another Revere Baltimore plant, new extrusion presses and draw benches are being put in place. Equipment for the production of aluminum coiled sheet was installed in our Detroit plant over a year and a half ago. In about a year, the Los Angeles mill, now working with copper and copper-base alloys only, should begin to produce aluminum tube and extruded shapes in both the heat-treated and non-heat-treated alloys.

These plans to increase materially the Revere output of aluminum mill products will make them more quickly and easily available in various industrial centers. Here is evidence of our belief that the future of aluminum is as great as that of copper. Each has its place, in peace as well as war.

Revere's thirty-year growth in aluminum is in the American tradition of freedom to seek new ways to serve customers. It is typical of the business world, for in many thousands of companies the original products or lines have been expanded to include more or less related items. So we suggest that no matter what you buy, you ask your suppliers if they have other materials or products that would be of value to you. The more you know about what your suppliers make, the greater the possibility of improving your products or productivity.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N.Y.

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

Personals

Charles R. Rainesalo is presently employed by the General Electric Co., Schenectady, on the chemical and metallurgical training program.

W. H. Shafer, a captain in the Army Ordnance Corps, is presently assigned to the Watervliet Arsenal, Watervliet, N. Y. He graduated from Rensselaer Polytechnic Institute last June.

Robert R. Penman has left his position as manufacturing test engineer in Ford Motor Co.'s Dearborn (Mich.) iron foundry to accept a position as plant metallurgist for the Macon Arms Division of Houdaille-Hershey Corp., Decatur, Ill.

Earl M. McCullough, who graduated from the South Dakota School of Mines and Technology last June, has taken a position as metallurgist with the materials engineering department of Deere & Co., Moline, Ill.

Michael Hrees, Jr., has accepted a position as turn supervisor, metallurgical and inspection department, at U. S. Steel's Fairless Works, Pittsburgh.

Arthur W. Thornton, formerly division superintendent in charge of pipe production, finishing and shipping, has been made assistant general superintendent at the National Works of U. S. Steel's National Tube Division, Pittsburgh. He has been with the company since his graduation from Lehigh University in 1931.

J. Ralph Macon has recently been appointed sales and service representative in the ordnance field for Pennsylvania Salt Manufacturing Co., Philadelphia.

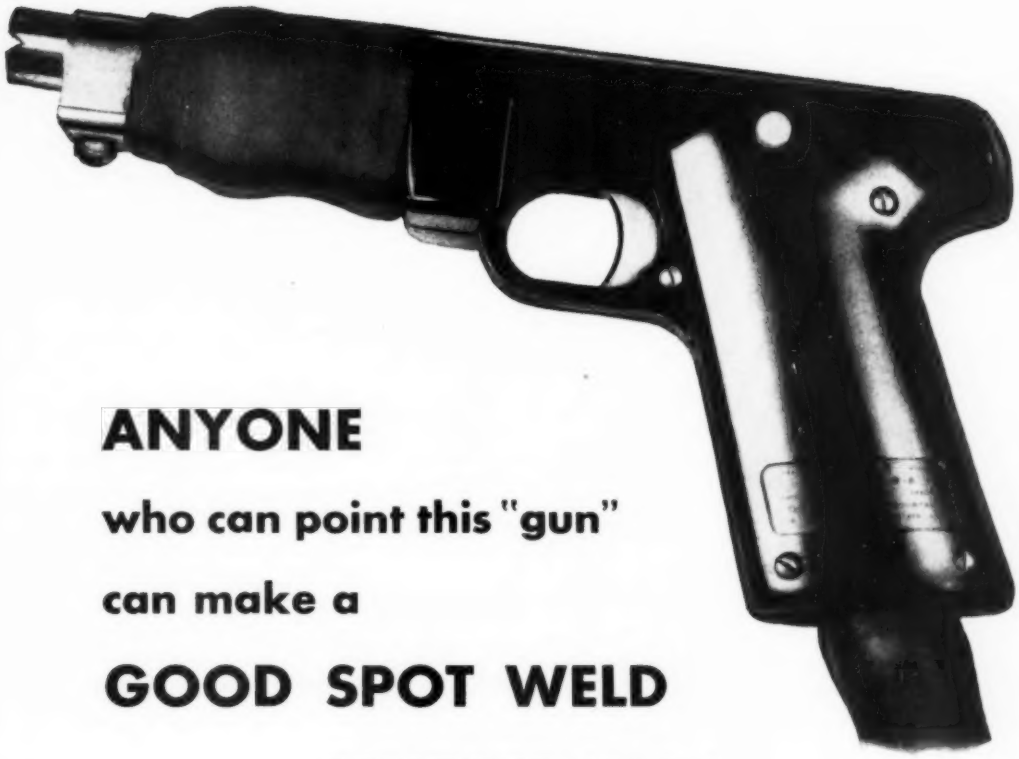
Walter E. Shoff has been appointed director of purchases at the Walker Manufacturing Co., Racine, Wis. He was formerly in charge of the steel and forging purchasing division for Caterpillar Tractor Co., Peoria, Ill.

Tom H. Spencer, formerly heat treat superintendent, has been promoted to assistant chief metallurgist at Caterpillar Tractor Co., Peoria, Ill., and **Frank Vaughn**, formerly assistant chief metallurgist, will direct activities in the metallurgical laboratory and be responsible for providing adequate technical assistance to other departments and suppliers.

Robert F. Thomson has recently been named head of the department of metallurgy, General Motors Research Laboratories, Detroit. He was formerly assistant head of the department. Dr. Thomson is vice-chairman of the Detroit Chapter of A.S.M.

R. C. McMaster, of Battelle Memorial Institute, Columbus, Ohio, will deliver the American Society for Testing Materials 26th Edgar Marburg Lecture. He will speak on Nondestructive Testing. Dr. McMaster was chosen to give the talk because of his outstanding work in the field and his close connection with ASTM's Committee E-7 on Nondestructive Testing. The first H. W. Gillett Memorial Lecture will be given by **N. L. Mochel**, manager of metallurgical engineering, Westinghouse Electric Corp. His subject will be Man, Metals and Power. These talks will be given during the Fiftieth Anniversary Meeting of the ASTM to be held in New York during the week of June 23.

Know-don't guess-
the Hardness of
your metals---before
and after machining
Ames PORTABLE
HARDNESS TESTERS
Show the exact hardness of your metals before and after heat-treating, to reduce tool wear and breakage and to speed up production.
Ames Portable Hardness Testers are light in weight and are carried to the work. Tests are easy to make and accurate, requiring no skill.
Ames Portable Testers are used to test flats, rounds, strip, tubing, wire, etc., without cutting off specimens. Saws, gears, knives and large irregular shapes are tested while assembled. Readings are direct in the Rockwell Scales.
Send today for interesting folder
"Rockwell Hardness Testing Made Easy"
AMES PRECISION MACHINE WORKS
Waltham 54, Mass., U.S.A.



ANYONE

who can point this "gun"

can make a

GOOD SPOT WELD

"HELIARC" HW-8 Pistol-Grip Torch
needs no forging pressure...works from one side of sheet... spot welds both STAINLESS and CARBON STEELS

Are you using light gage metals to fabricate large assemblies or irregular shapes? If so, chances are you can simplify many of your joining problems, boost production, and cut costs, too, by spot welding with the HELIARC HW-8 Torch.

The HW-8 joins mild steel, low alloy, or stainless steel .020 to .064 in. thick at one to two seconds per weld. Because it works *from one side of the sheet*, without forging pressure, it makes an easy, one-hand job of spot welding — even in places where resistance welding is not practical or possible.

Connected to a suitable power source with auxiliary timer, the HELIARC Spot Welding Torch makes inert gas shielded welds without fumes, smoke, or spatter. Since operation is automatically controlled, workmen on the assembly line need only press the "muzzle" of the "gun" against the work and pull the trigger. A single hose assembly permits free use of the torch over a 25-ft. radius.

For further information, telephone or write today, LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y.

The term "Heliarc" is a registered trade-mark of Union Carbide and Carbon Corporation.

Linde Trade-Mark

Products and Processes for MAKING, CUTTING, JOINING, TREATING, and FORMING METALS

MORE than a "Coolant" is needed

"COOLANT" is a misnomer as applied to *cutting fluids*. You won't get far with just a coolant. The fluid used for metal cutting must have multiple characteristics in order to provide the desired finish and tool life at the required production rate:

- **Cooling Action** — very necessary to carry away the heat generated by machining, but only part of the function.
- **Lubricity** — to reduce friction between the tool point and the work piece. The lubricating qualities of the cutting fluid make a big difference.
- **Anti-Weld Properties** — to prevent build-up of metal on the tool and scuffing of the work piece. The amount of anti-weld agent in the fluid is a critical factor and depends on the job.

These factors and others are all inter-related. Over-simplification of the subject and the cutting fluid can lead to trouble. Let a Stuart sales-engineer show you what can be accomplished with the *right* cutting fluid.

Ask for Bulletin

Get the Facts
Visit the
STUART BOOTH
No. 1823
at the
ASTE SHOW
Chicago, Mar. 17-21

D.A. Stuart Oil co.

2743 S. Troy Street, Chicago 23, Ill.

TIME-TESTED
Cutting Fluids and Lubricants

Personals

Arthur W. Frank has recently been promoted to chief engineer of the Hevi Duty Electric Co., Milwaukee, Wis. He was formerly the company's director of research.

James R. Thompson, after a half-century of service with the American Steel & Wire Co., Cleveland, has recently retired. He held the position of manager of the company's metallurgical department before his retirement.

Earl W. Cunningham has been named general manager of the General Electric Co.'s industrial heating department, Schenectady.

Carl A. Meyer, Jr., has accepted a position as metallurgist in the quality control department of the Weirton Steel Co., Weirton, W. Va. He graduated from University of Pittsburgh in February.

John G. Leschen, a member since 1946 of General Electric Co.'s research laboratory, Schenectady, in the metallurgy research department, has been appointed liaison representative in the field of metallurgy at the laboratory.

Fred W. Vogel, formerly managing editor of *Modern Machine Shop*, has been named editor, replacing **Howard Campbell**, now editor emeritus. Mr. Vogel has been associated with the magazine in an editorial capacity for more than 16 years. Mr. Campbell, a co-founder of *Modern Machine Shop*, will remain as chairman of the board of the firm, Gardner Publications, Inc., Cincinnati.

John Warywoda has been employed as application engineer in the hydraulic turbine department of Allis-Chalmers Ltd., Lachine, Quebec, Canada.

Charles H. Barnett has recently been promoted to assistant to the president of the Foundry Equipment Co., Cleveland. He has been with the company since 1947 as sales engineer and has also handled technical publicity.

John J. B. Rutherford, metallurgist for the tubular products division of the Babcock & Wilcox Co., Beaver Falls, Pa., has been appointed a member of the Interim Advisory Committee on Alloy Steels of the American Petroleum Institute.

a few words about alloy steels

and how we can help you switch to ALTERNATE ALLOY GRADES

You've probably had trouble getting the alloy steels you've been accustomed to running. You've got the headache of choosing the best available alternate alloys, plus the headaches of how to machine and heat-treat them.

That's where we can help . . .

Republic 3-Dimension Metallurgical Service combines the experience of your metallurgist and your production men with our 3-man team . . . the Republic Field and Laboratory and Mill Metallurgists. You tell us what you want the steel to do . . . we tell you the best available alternate, help you take the bugs out of using it.

In spite of restrictions you can probably switch to one of the many grades being made by Republic . . . world's largest producer of alloy and stainless steels.

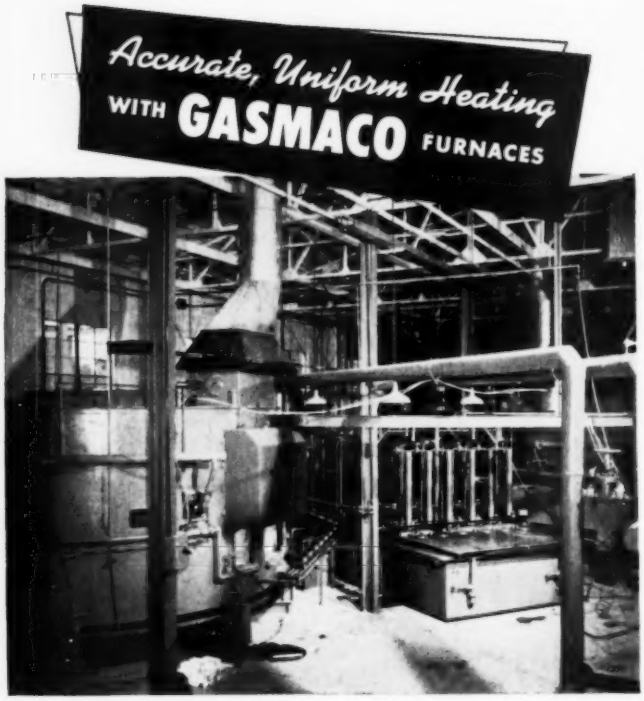
When may our Republic Field Metallurgist call?

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

LAB MILL FIELD
3-DIMENSION Metallurgical Service

REPUBLIC STEEL
Republic ALLOY STEELS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing



In the production of 105 mm shells, accuracy and uniformity of heating are of vital importance. To obtain necessary tolerance, without the use of valuable alloys, two Gasmaco furnaces are employed — one for hardening and the other for drawing. A quench tank is located between the furnaces on this operation, which requires the services of only two men.

The shells are hardened, quenched and drawn in a vertical position to ensure positive uniformity and accuracy. The result is better quality, faster production and lower cost.

For your heat treating problems and other furnace requirements, investigate the many advantages of Gasmaco. Call or write today.

SALES REPRESENTATIVES

LEWIS C. BAXTER
2207 Ashland Avenue
Toledo 10, Ohio

EMIL J. KLIKA
53 West Jackson, Room 733
Chicago 4, Illinois

McCONNELL SALES & ENGR. CORP.
2809 Central Avenue
Birmingham 9, Alabama

CHRISTY FIREBRICK CO.
506 Olive Street
St. Louis 1, Missouri

C. E. NOBLE
The Noble Equip. Co.
P. O. Box 314
LaGrange, Ohio

THE GAS MACHINERY CO., (Canada) Ltd.
9 McNab Street
Hamilton, Ontario, Canada

THE GAS MACHINERY COMPANY
16136 WATERLOO ROAD
CLEVELAND 10, OHIO

Designers • Fabricators • Erectors
Gas Plant Equipment and Industrial Furnaces
THE GAS MACHINERY CO. (Canada), Ltd.
HAMILTON, ONTARIO

Personals

Adolph M. Hubbard has been employed as a metallurgist by the Westinghouse Electric Corp., Sunnyvale, Calif., since his graduation from Stanford University last June.

Vijay G. Paranjpe, formerly research associate at Massachusetts Institute of Technology, Cambridge, Mass., has joined the National Metallurgical Laboratory, Jamshedpur, India, as a senior scientific officer in the physical metallurgy division.

Kenneth O. Robinson has been employed as chief of the laboratory division, industrial section, headquarters, Japan Procurement Agency, by the U. S. Army for the past two years, where his duties have been to develop a materials testing laboratory for materials procured for the Armed Forces.

Donald J. McPherson and **Harold D. Kessler**, research metallurgists in the metals department at Armour Research Foundation, Illinois Institute of Technology, Chicago, have been promoted to supervisors. Dr. McPherson will head the physical metallurgy section and Mr. Kessler the nonferrous metallurgy section.

Mars G. Fontana, professor and chairman, department of metallurgy, Ohio State University, Columbus, Ohio, has been elected president of the National Association of Corrosion Engineers.

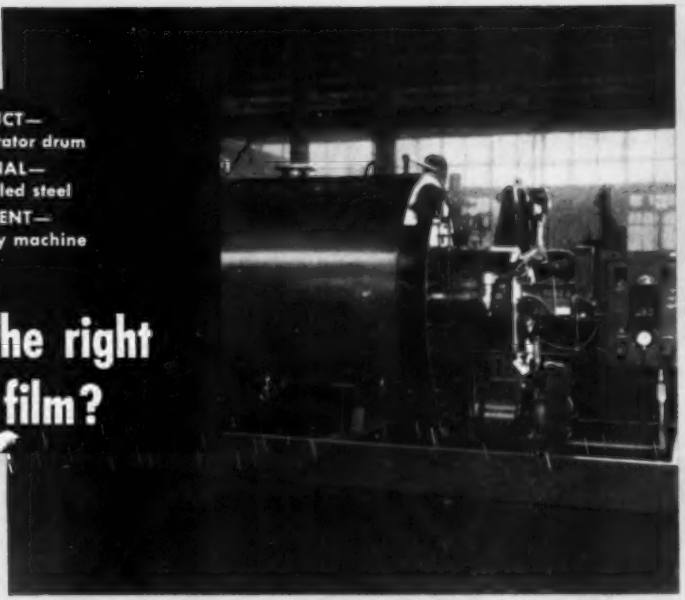
William P. Achbach has recently changed from his position as project engineer, central engineering, Chrysler Corp., Detroit, to that of experimental metallurgist, Aeroproducts Division, General Motors Corp., Dayton, Ohio.

Robert B. Coleman has been named manager of sales operations for the Lamson Corp., Syracuse, N. Y. He was formerly with the American Chain and Cable Corp. as eastern regional manager of the Wilson Instrument Division and the Campbell Machine Division.

Harry Y. McCool has recently been appointed service director of the city of Canton, Ohio. He is a veteran of 52 years in the steel industry, having retired in 1947 from the Timken Roller Bearing Co., Canton, where he had served as superintendent of maintenance in the steel and tube division for nine years.

PRODUCT—
Steam generator drum
MATERIAL—
13/32" rolled steel
EQUIPMENT—
250 kv x-ray machine

What's the right x-ray film?



KODAK INDUSTRIAL X-RAY FILM, TYPE A

MUCH IS GAINED by welding a pressure vessel. In this case dependability of the generator was increased, while weight was reduced 15% and costs dropped 10% to 20%. But each weld must be proved sound radiographically.

To make the radiographs, the radiographer used 145 kv, and Kodak Industrial X-ray Film, Type A, with .005-inch front-and-back lead screens.

Type A has high contrast and fine graininess, and sufficient speed to take full advantage of high kilovoltage machines in radiographing thick or dense materials. It also is first choice for the examination of light alloys with short exposures at low voltage.

A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check welds and castings efficiently and thus extend their use.

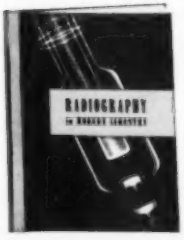
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
X-ray Division • Rochester 4, N. Y.

Kodak
TRADE-MARK

Defects in Rolled Products*

OCCASIONAL appearance of certain defective conditions during rolling cannot be avoided, and their cause is often a controversial issue between the melting shop and the rolling mill. However, a clear-cut identification of their origin enables the management to determine in which department the ultimate source is located and thereby eliminate this source almost as soon as it arises.

The purpose of the report is to identify and group such defects into: *(a)* Material defects which originate in the melting shop; *(b)* defects which arise in the rolling mill; *(c)* defects which can be remedied through a definite heat treatment in the rolling mill, that is, red shortness, hot cracks and such. The report in many instances suggests the remedies.

The material defects given under the first group are pipes and blowholes, banded structures and inclusions, and flakes.

Pipes and blowholes which are not welded together during rolling cause internal surfaces of separation in the metal, making it unfit for use. These flaws can be readily identified on fractures or on etched sections. The upset test will reveal blowholes located near the surface.

Since pipe occurs in the top of ingots, this part is often burned off. Frequently, superficial blowholes in high-quality steels are eliminated from the billets by turning them in a lathe. Pipe or blowholes having bright and clean walls can be welded together by rolling at high temperature. Even the blowholes with oxidized walls may be welded shut when the steel is sufficiently high in carbon to enable the oxides to be reduced.

Banded structure originates from dendritic or globular primary crystals of heterogeneous composition. Normal or inverted ingot segregation and segregation surrounding blowholes comprise additional sources. Blowhole segregation creates more nonuniformly distributed bands than crystal segregation. However, the most harmful causes of banding are plastic nonmetallic inclusions, such as silicates, which act as nuclei for primary and secondary crystallization. A pronounced ferrite precipitation always takes place on the elongated silicate inclusions and the transverse "sensitivity" of the material is greatly increased.

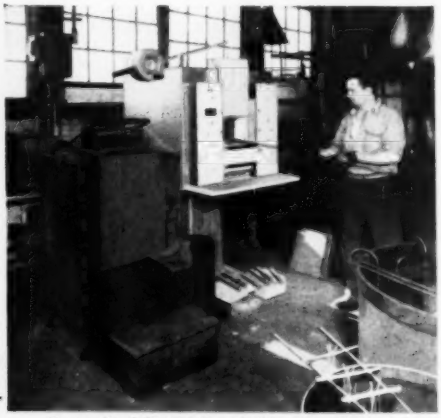
Sulphur, phosphorus and carbon segregate most strongly in steel, especially around blowholes. High-temperature annealing will distribute carbon which diffuses with comparative ease, but not sulphur and phosphorus. The rolled surface may look smooth and free from defects and yet exhibit flaws after pickling because of scale-filled veins that emanate from the surface. Pickle blisters arise when atomic hydrogen diffusing into the steel encounters larger nonmetallic inclusions, where it associates to the molecular form and attains sufficient pressure to bulge the sheet. Blisters on hot-rolled sheets are most frequently due to iron oxide inclusions.

Flakes, which may lower the fatigue limit, are transcrystalline cracks which appear after hot forming. They mainly are due to the pressure built up through the

(Continued on p. 100)

*Abstract of "Defects in Rolling", by Paul Grüner and T. Brüggeman, Report No. 193 of the Subcommittee on Rolling, Verein Deutscher Eisenhüttenleute.

1ST IN HIGH SPEED STEEL HEAT TREATING



Sentry Models 2B-YP and 5Y are installed at Whitin Machine Works, Whitinsville, Mass.

Sentry

Whitin Depends on Sentry for Uniform Tool Hardness!

"Our high-speed steel cutting tools get the uniform, swift, economical Sentry treatment, and we get tools hardened to perfection without distortion or troublesome "skin". A sample production day for one Sentry furnace is 92 large pieces."

See the Sentry Exhibit in Booths 1930—1952 Industrial Exposition, Chicago, Ill.

REQUEST CATALOG W-2

ALWAYS ON DUTY

SENTRY MODEL YP
Vertical model for long, slender drills, reamers, broaches, etc.

SENTRY MODEL 2Y
For small tools, cutters of moly, tungsten and cobalt high speed steels.

THE SENTRY COMPANY

INDUSTRIAL ELECTRIC FURNACES AND EQUIPMENT FOR HEAT TREATMENT OF METALS

Legs for lethal eagles

Legs for lethal eagles – hydraulic landing gear that cushion Uncle Sam's big bombers as they come down to roost – this is just one of the many uses of OSTUCO Tubing by manufacturers in the progressive aircraft industry. Aircraft designers are specifying OSTUCO Tubing for fuel lines, engine mounts, landing gear, and many other applications because of its inherent strength without weight characteristics and the ease with which it can be machined, formed and fabricated to the most exacting requirements.

But whether your products are aeronautical or of a distinctly different nature, you owe it to your future to investigate the advantages of OSTUCO Tubing for improving quality and reducing cost.

We cannot always promise early delivery estimates on new civilian orders, because of military demands, but it will pay you to consult our experienced engineers about OSTUCO Tubing when redesigning your products to meet future competition.

From Your Blueprint . . . to Your Product
OSTUCO TUBING
Tapering • Swaging • Flanging • Bending
Upsetting • Expanding • Reducing • Beading
End closing • Spinning • Drilling • Slotting
Notching • Flattening • Shaping • Trimming
Threading • Angle Cutting • And Many Others

THE OHIO SEAMLESS TUBE COMPANY

Manufacturers and Fabricators of Seamless and Electric Welded Steel Tubing

Plant and General Offices: SHELBY, OHIO

OSTUCO SHELBY, OHIO

SALES OFFICES: Birmingham, P. O. Box 2021 • Chicago, Civic Opera Bldg., 20 N. Wacker Dr. Cleveland, 1328 Citizens Bldg. • Dayton, 511 Salem Ave. • Detroit, 520 W. Eight Mile Road, Ferndale • Houston, 6833 Avenue W, Central Park • Los Angeles, Suite 300-170 So. Beverly Drive, Beverly Hills • Moline, 617 15th St. • New York, 70 East 45th St. • Philadelphia, 1613 Packard Bldg., 15th & Chestnut • Pittsburgh, 1206 Pinewood Drive • St. Louis, 1230 North Main St. • Seattle, 3104 Smith Tower • Syracuse, 501 Roberts Ave. • Tulsa, 733 Kennedy Bldg. • Wichita, 622 E. Third St. • *Canadian Representative:* Railway & Power Corp., Ltd.

Defects in Rolled Products

(Continued from p. 98)

precipitation of molecular hydrogen from the solid solution. Since they are pure metallic rifts, further hot rolling will weld them together. They are easily recognized as bright and shiny areas on the fracture or as hairlines on hot etched disks.

Group *(b)* or rolling mill defects can arise from any of the following: Faulty heating; overlapping; rolled-in foreign substances; defective fixtures; damaged or badly functioning rolls.

Faulty Heating—The forging cross often appears when the deformation has been conducted below A_3 and is the result of great stress concentration in the diagonal planes. Further rolling often leads to cracks in the core of the section. The primary structure may show little contrast and the microstructure may reveal no peculiarities. However, the fracture may be either coarser or finer in the forging cross than in the rest of the section.

Grain growth and Widmanstätten structure will result from too high a rolling temperature. The steel may become very brittle.

Temperature of the material should be measured after the first pass when the scale has been broken off. Long bars should be tested from end to end because excessive temperature variations can cause variations in grain size along the entire bar. The quality of the rolled product depends greatly on the temperature distribution in the material during the entire rolling process, as well as on close temperature control, rate of deformation and speed of rolling. Overheated steel, which has developed coarse grain and Widmanstätten structure, can often be restored through subsequent annealing but burned steel is beyond repair. Burning occurs only after extensive decarburization.

Overlapping may result from poor adjustment of the rolls or excessive spreading due to low rolling temperature, causing the steel to enter the space between the rolls and form fins which cool faster than the body of the section. If the profile is edged in the next pass the fin is pushed into the material, eventually causing overlapping which appears as "seams" on two longitudinal faces of the section. The quality of the product, especially of small sections, may be considerably impaired.

This condition may be recognized by the appearance of the segregation zones on a cross section of the material. The surface zone may be displaced locally, enough to bare the center zone which sometimes lacks sufficient plasticity to be deformed under such conditions. It may be subject to cracking because of sulphur and phosphorus segregations, although it can be deformed without trouble as long as it remains completely embedded in the sounder surface material.

A condition resembling overlapping can arise when superficial blowholes are opened during rolling as a result of the scaling away of the material layers which originally protected them from contact with the furnace atmosphere. If no decarburization has occurred in the defects one can usually conclude that they were due to blowholes rather than to overlapping.

Rolled-in foreign material may consist of small scraps that accidentally enter the furnace, weld to the ingot surface and remain undetected under the scale. Consequently, such scraps will then be rolled into the section to form a

(Continued on p. 102)

This book, in your hands, may well solve all your problems of BLACK OXIDE finishes for metal.

Here is data on tanks, temperatures, cleaners—and the facts about BLACK MAGIC Type A BLACKENING SALTS.

This new BLACK OXIDE finish easily blackens heat-treated pieces, uses less salt, operates at a lower temperature, requires no rectification by cyanide additions, requires only one tank, one salt.

BLACK MAGIC MEETS GOV'T SPECS 57-0-2C Type 3, 51-70-1A Finish 22.04, AMS 2485 and all other black oxide specs.

WRITE TODAY for your copy of the BLACK BOOK.

THE MITCHELL-BRADFORD CHEMICAL CO.
Stratford, Connecticut
Please send me the BLACK BOOK on Protective Finishes.
Name ..... Position .....
Company .....
Address .....
City ..... State .....

Mitchell-Bradford

THE MITCHELL-BRADFORD CHEMICAL CO.
2446 MAIN ST. STRATFORD, CONNECTICUT
Sales and Technical Service also available at our Chicago office.
7001 North Clark. Representatives in all leading cities.

QUALITY PRODUCTS OF CHEMICAL RESEARCH

better measurement and control of

HUMIDITY

Ever since the origination of accurate humidity control by Foxboro, this Company has been foremost in the development of instrumentation for absolute humidity, relative humidity, moisture content and dew point . . . whether in gas, air, bulk materials or moving sheet stock. The high quality standards and complete diversity of Foxboro Instruments . . . backed by Foxboro's broad experience . . . offer you unmatched facilities for obtaining the most efficient system for your operation.

INDICATORS • RECORDERS • CONTROLLERS

hygroscopic, wet-and-dry bulb, capacitance, plus the unique "Dewcel" system for continuous recording and control of either absolute humidity or dew point.

TRANSMISSION SYSTEMS • CONTROLLED VALVES

FOXBORO

Reg. U. S. Pat. Off.

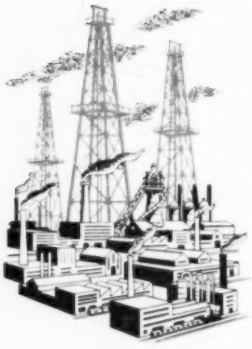
for over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .

THE FOXBORO COMPANY, FOXBORO, MASSACHUSETTS, U. S. A.

More Natural and Coke Oven Gas

Now Used in

Birmingham District than Greater New York

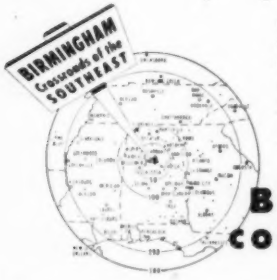


SOUTHERN NATURAL GAS COMPANY—headquarters Birmingham—has increased its system's capacity more than 175% in the past five years. This Company transports natural gas to Alabama and adjacent States. Alabama Gas Corporation, a subsidiary, distributes this gas to the Birmingham district and 32 municipalities in central Alabama. It also distributes coke oven gas, produced in Birmingham, to users in this area. Construction of 109 new coke ovens by Alabama By-Products Corporation, Sloss-Sheffield Steel & Iron Company and Republic Steel Corporation will increase this coke oven gas supply 33 1/3% by early 1952.

Christopher T. Chenery, Chairman of the Board of Southern Natural, has cited these reasons for his Company's great growth:

"Our Company's expansion mirrors the spectacular advance of the Birmingham district and our markets in the Southeast. Our section has become one of the country's important industrial areas. Transition from a cotton-dominated region to one of diversified industry and agriculture has been an outstanding factor in its economic progress. This has helped create a buying power that today absorbs a steadily increasing volume of manufactured goods. Growing purchasing power of the colored population has likewise been most important. Their living standards have risen remarkably fast. Our Company foresees acceleration of the present industrial development throughout our territory. This is why we have projected a further long-range program to provide additional capacity, far exceeding that we have today."

• • • • • • • •



Central district of the Southeast is Birmingham. The Committee of 100 or any of the undersigned members of the Executive Committee will welcome your inquiries for specific, confidential data regarding the advantages of this district for your plant, office or warehouse.

BIRMINGHAM
COMMITTEE OF 100
1914 Sixth Ave., N., Birmingham, Ala.
Executive Committee

Gordon Persons
Governor
State of Alabama
Bradford C. Colcord
President
Woodward Iron Co.
John S. Coleman
President
Birmingham Trust National Bank
Donald Comer
Chairman of the Board
Avondale Mills
William P. Engel
President
Engel Companies
W. W. French, Jr.
President
Moore Handley Hardware Co.
Clarence B. Hanson, Jr.
Publisher
The Birmingham News
W. H. Hoover
President
Employers Insurance Co. of Alabama
Mervyn H. Sterne
Sterne, Agee & Leach
Claude S. Lawson
President
Sloss-Sheffield Steel & Iron Co.
Thomas W. Martin
Chairman of the Board
Alabama Power Co.
J. C. Persons
President
First National Bank
O. W. Schanbacher
President
Laveman, Joseph & Loeb
A. V. Wiebel
President
Tennessee Coal, Iron & Railroad Co.

Defects in Rolled Products

(Continued from p. 100)

perfect weld that is hard to detect. Even nonmetallic matter such as brick fragments may bake on to the hot ingot surface and may damage the rolls as well as the surface of the bars if not discovered in time.

Defective Fixtures—Scratches from guides and guards arise easily if their contact surfaces are not absolutely smooth. Scratches made in early passes may be closed in succeeding passes and will then resemble overlaps. High-nickel steels are especially sensitive to scratching by the slightest roughness in the guiding equipment. Very high rolling temperatures promote scratching. Use of guides with hardwood inserts is recommended for chromium steels.

Poor adjustment of the guides can lead to "self-twisting" of round, square and flat bars, and profiles. Such twisting may also be caused by poor roll alignment.

Poorly Functioning Rolls—"Grinding" of the grooves causes surface defects which align themselves in all imaginable directions. Too deep ragging causes projections on the billets which upon contact with the collars between the grooves may cause grinding. The ragging should be welded on the rolls and subsequently ground smooth.

Grinding can also result from the dragging of the bars against the rolls, especially in three-high mills working with overdraft where the diameter of the top roll is greater than that of the middle roll. Here, the bar is pushed against the front conveyer roll after having been disengaged by the scraper, and the dragging arises from the different velocities imparted to it from above and below. Hence, the greater the difference in roll diameter, the more roughened the rolls, together with a harder and colder steel, the greater becomes the drag. The layers of the material are differently strained when the drag is high. Defects originating from grinding and drag are usually discovered shortly after rolling, whereas faults due to a bad roll surface often are more difficult to identify.

Excessive rolling speed causes creeping between the rolls and product and this lessens the ability of the rolls to "bite" the steel. The grooves soon get rough in rolling alloy steels and may cause superficial cracks. Rolls must be as

(Continued on p. 104)

N·A·X
HIGH-TENSILE STEEL

means less weight with no loss of strength or quality

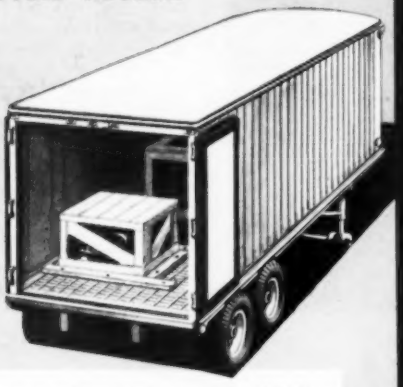
FOR BUSES . . .

The greater strength and toughness of N-A-X HIGH-TENSILE steel permits reductions of up to 25% in section without sacrificing durability or safety of product.

TRUCKS . . .

Through the use of this low-alloy, high-strength steel, with its enhanced resistance to corrosion, less dead-weight in military and civilian transportation equipment means greater payloads and longer life.

. . . AND TRAILERS



N-A-X HIGH-TENSILE steel, with its high degree of cold formability and excellent welding properties, permits a manufacturer of transportation equipment to fabricate it with the ease of mild carbon steel.

These few examples illustrate the use of N-A-X HIGH-TENSILE steel in transportation equipment. By utilizing its increased strength and toughness—its greater resistance to corrosion, abrasion and fatigue—its excellent response to fabricating and welding—you can make more products from the same tonnage of steel . . . an important contribution to conservation.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

an

ODD SHAPE *in*

stainless plate?

Not at G. O. Carlson, Inc., for our complete service in stainless plate items is backed up by special cutting equipment and techniques which have been developed and refined over the years. "Odd" shapes are routine at G. O. Carlson, Inc.

While many of our customers purchase their stainless plate in sheared rectangles, many others prefer that we ship their orders cut to pattern. In these days of emergency, valuable time, labor and critical material are usually conserved by specifying that plate be pattern cut.

Year in and year out, you can be assured that stainless plate from G. O. Carlson, Inc. is delivered to your specifications.

Stainless steel is our only business . . . and we know it.

G. O. CARLSON, INC.

Stainless Steels Exclusively

300 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

District Sales Offices and Warehouse Distributors in Principal Cities

Defects in Rolled Products

(Continued from p. 102)

smooth as possible to produce a good surface on the steel. Excessive creep in combination with high draft may result in depressions due to tiny spotwelds (between the rolls and the steel); these are later squeezed together to form folds which appear as crack formations of almost any length under comparatively strong hot etching. Their prevention requires vigilant inspection of the roll surfaces and of the product.

Pressure cracks in alloy steels are due to excessive spreading, especially in alloy steel. They are formed from the edging of a section wherever any fins have formed in the space between the rolls and are scarcely distinguishable from cracks due to folding.

Red short or hot short steel can leave the rolling mill entirely acceptable if properly heated and handled. Armco iron, for instance, is always red short and would disintegrate if rolled in the dangerous temperature range.

Oxides occurring between primary crystals cause the poor workability in the red shortness range; intergranular, liquefied sulphides cause hot shortness. The addition of manganese counteracts both conditions. High temperature diffusion annealing can reduce hot shortness but not red shortness. Red short steels can be worked without trouble between 2000 and 2190° F., the dangerous range lying between 1470 and 1830° F. The steel must absolutely be finished above that range to avoid trouble.

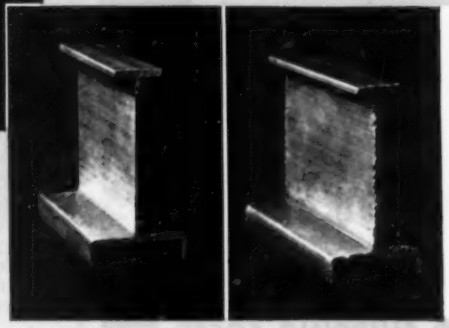
In summing up, the author states that the descriptions and illustrations provide the qualified technician with a manual of defects in rolled products which is applicable to forged and pressed material as well. The illustrations are, in general, not of the excellent quality usually found in leading American metallurgical publications. The discussion of banding as a cause of material failures is typical of the metallurgist's oftentimes exaggerated readiness to blame service failures on the various deviations from idealized conditions which nearly always can be observed in commercial products. On the whole, the report has considerable value as a guide in the identification of the numerous and often subtle sources of defects in rolled products.

C. A. Liedholm

NEW! Johnson's STIK-WAX

An entirely new kind of lubricant that

outperforms grease sticks, tallow, bar soaps!



Sawed sections of aluminum extrusion. Left: section sawed with Johnson's No. 140 Stik-Wax is burr-free. Right: section sawed with grease stick shows bad burr.

On grinders
Stik-Wax lubricates to reduce heat—wheel clogging.

On belt sanders
Stik-Wax lubricates to give better finish—longer belt life.

On taps
Stik-Wax lubricates to cut smoother threads — increase life of taps.

On band or circle saws
Stik-Wax lubricates to lengthen blade life —gives smoother cuts —reduces burns.

Johnson's No. 140 Stik-Wax is the new wax lubricant that outperforms grease sticks, tallow, bar soaps. Saves materials and tools . . . saves time . . . produces higher quality work.

Exhaustive tests have shown that the performance of Johnson's No. 140 Stik-Wax far exceeds that of ordinary lubricants for drilling, grinding, sawing, tapping, spinning and pipe cutting. Taps and drills last far longer. Saws and cutters need sharpening much less frequently. Sanding belts and disks get added life . . . give cleaner, smoother finishes.

Applied manually or automatically, there is no end to the metal working lubricating jobs that Stik-Wax will do *better* to *speed* jobs . . . *add life* to equipment.

A product of JOHNSON'S WAX Research

Test STIK-WAX in your plant—

FREE!

Industrial Products Dept. MP-3
S. C. Johnson & Son, Inc.
Racine, Wisconsin

Please send free sample of Stik-Wax for testing . . . also send complete information and instructions for use.

Name _____ Title _____

Organization _____

Address _____

City _____ State _____

LOW COST
IRIDITE®
FINISHES
for zinc, cadmium, aluminum and cuprous metals
provide corrosion resistance
paint base
choice of appearance
And they are easy to apply! Just a simple chemical dip for only a few seconds produces the coating.
LOW MATERIAL AND SHIPPING COSTS
combine to make Iridite the most economical chromate finish you can buy. Many Iridite chemicals are packed in powder form, thus can be shipped to you in steel pails at freight savings of up to 75%! Pails take less storage space, are easier to handle, eliminate carboys, need not be returned.
WHY NOT TEST IRIDITE ON YOUR PRODUCTS? Write for literature and send samples for free test processing. See "Plating Supplies" in your classified telephone directory or write direct.
ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

Factors Influencing Structure of Electrodeposits*

THE STRUCTURE of electrodeposits is classified by the author into two main groups, normal and abnormal structures. Under the former he lists the columnar as the common form and the nodular shapes and banded deposits as minor or less common forms, with the conical and acicular crystals and fan-like groups being listed as variants. The defects and abnormalities include: Large nodules, trees, pits, blisters, cracks, burned and powdery deposits.

The growth of electrodeposits is affected by various conditions which are tabulated as follows:

Primary Factors

1. Rate of arrival and discharge of ions at cathode.
2. Mobility of ions over cathode surface.
3. Atomic arrangement of substrate.
4. Concentration of deposit on projections.
5. Extent and nature of adsorption or co-deposition of other ions, atoms, molecules and colloids.

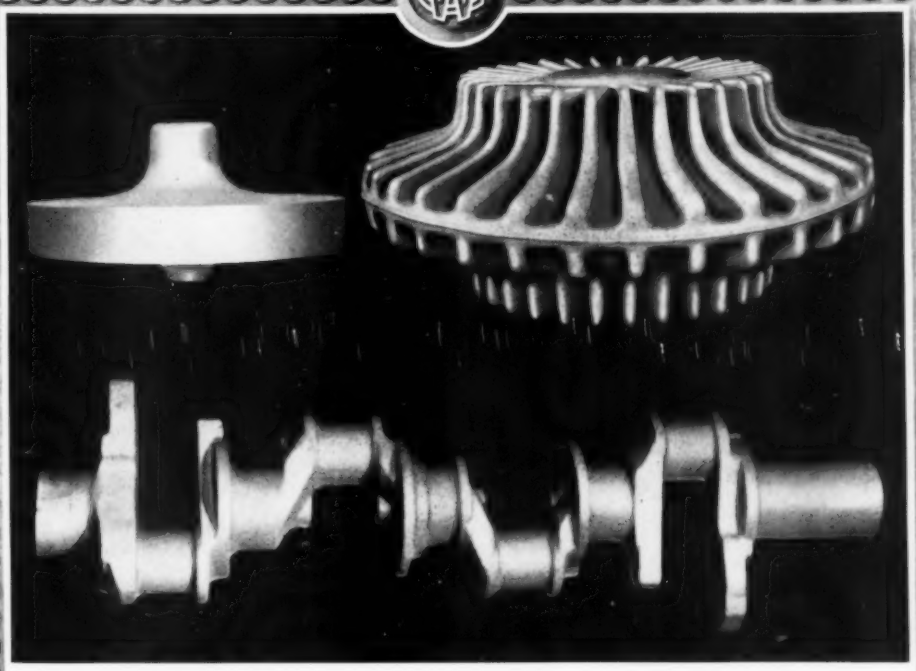
Secondary Factors

1. Electrolyte concentrations.
2. Temperature.
3. Current density.
4. Degree of stirring and convection.

In general, any condition tending to increase the supply of ions available for discharge at the cathode favors large grain size. The type of electrolyte plays a big part in determining grain size. There are two main classes covering the majority of commercially used plating solutions, namely acid and cyanide. Deposits from acid baths (copper and nickel) are normally large-grained, columnar and, incidentally, are frequently twinned. Cyanide baths, on the other hand, invariably give fine-grained, often microscopically irresolvable, deposits because the metal in any cyanide bath is always present in a complex ion, which itself is only very slightly ionized so that the actual metal ion concentration is extremely low. This applies equally to other types of baths based on

(Continued on p. 108)

*Abstract of "The Structure of Electrodeposits", by J. J. Dale, a paper presented before the Australian Institute of Metals, Physical Metallurgy Division, 1949, as part of the Symposium on Electrodeposited Metals.



Wyman-Gordon—specialists in the vital forgings of the internal combustion engine since its inception—is today the largest producer of crankshafts for the automotive industry and of all types of forgings for the aircraft industry. Be it crankshafts and other vital forgings for the piston type engines or turbine wheels and impellers for turbo jets—there is no substitute for Wyman-Gordon experience.

Standard of the Industry for More Than Sixty Years

WYMAN-GORDON

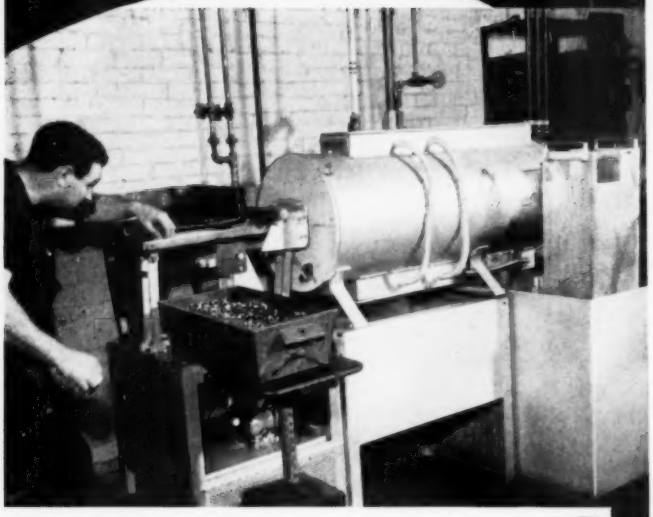
FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

RAYMOND MFG. CO.

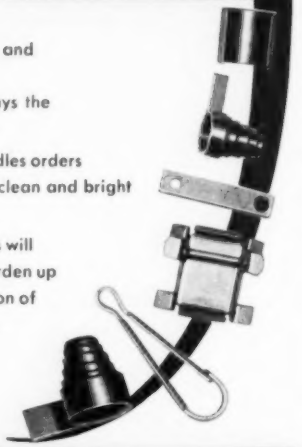
"Bright" Hardens Precision Springs in a HEVI DUTY Shaker Hearth FURNACE



"We bright harden carbon, vanadium, and stainless steel springs without distortion in our Hevi Duty Shaker Hearth furnace," says the Raymond Mfg. Co. of Corry, Pennsylvania.

"Our Hevi Duty Shaker Hearth furnace handles orders faster, and work comes out of the furnace clean and bright with no scale or decarburization."

Hevi Duty standard Shaker Hearth Furnaces will carburize, nitride, dry cyanide or bright harden up to 150 lbs. of small parts per hour. Operation of this production machine is semi-automatic. Write for bulletin HD-850 today.



HEVI DUTY®

HEVI DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces... Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

Factors Influencing Structure of Electrodeposits

(Continued from p. 106)

complex ion formation, but cyanide baths are by far the most common and typical of these.

In a given solution, increased metal content favors large grains; should the degree of ionization be decreased, for example by addition of another salt giving the common ion effect, then grain size is reduced. Changes in acidity or alkalinity of solutions do not appear to give consistent effects. An increase in current density favors reduced grain size because the increased rate of deposition depletes the metal ion content of the solution more rapidly in the vicinity of the cathode. There are occasional exceptions to this rule, as in nickel plating solutions within a certain pH range.

Increase in bath temperature results in very marked increase in grain size, due mainly to the increased mobility of the ions, which can thus more readily make good the depletion in the ion concentration in the cathode layer of liquid. Agitation favors increased grain size for much the same reason as does temperature, that is, it assists in bringing up fresh metal ions to the cathode layer.

The effects of inclusions and other foreign matter in the deposit are important and varied. They may interfere with crystal growth and thereby result in greater brightness; they may interfere with slip, producing harder deposits.

Early theories for brightening action were based on the very fine grain size of the deposits and on the possibility of preferred orientation, causing certain crystal faces to be laid out more or less flat on the surface so as to give a reflecting surface. However, observations of the degree of preferred orientation in bright-nickel deposits from different baths showed no consistency and it is evident that some other factor must be responsible.

The most recent explanation has been put forward by Gardam who has shown microscopically and chemically that sulphonates (the major class of organic additive agent in use) can be included in the deposit. A further pertinent fact is that most bright deposits, when examined microscopically, show a laminated or banded structure. Gardam supposes that a film of sulphonate is adsorbed on the

(Continued on p. 110)

"Dag" Colloidal Graphite... for Hot-Working Operations

At 500° F., and virtually as far up as you ever go in metalworking operations, **"dag"** colloidal graphite is a lubricant that does not gum up . . . that defies break-down. For brass, bronze, aluminum, magnesium, carbon steel and stainless steel . . . wherever your fabrication problems are friction and heat . . . this unusual lubricant reduces one and resists the other.

"Dag" colloidal graphite is available in dispersions designed to lubricate under all conditions of deep piercing, forging, stretch-forming, wire-drawing and ingot stripping . . . to assist in the parting of castings . . . to lubricate permanently parts that may be subject to extremely high temperatures . . . to be used in degreasing solutions which destroy ordinary lubricants.

When a **"dag"** dispersion is applied to the friction surfaces of metal it leaves a strong, durable graphoid film so thin that even the most sensitive gages cannot detect it. This lubricating film provides the metal with a surface that has an extremely low coefficient of friction . . . a lubricant that resists oxidation and functions far above the burning point of conventional petroleum lubricants.

For more information on the "Use of Colloidal Graphite for Metalworking Operations," write for Bulletin No. 426-10C.

dag DISPERSIONS

Acheson Colloids Company, Port Huron, Mich.

. . . also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND

Units of Acheson Industries, Inc.

How to cut hydrogen costs 66%

Dissociated Ammonia as a source of hydrogen can reduce your raw material costs by as much as 66%

In addition to this savings there is also an economy in cylinder handling costs and shipping charges. For it is a known fact that dissociation of one cylinder of ammonia yields the equivalent of 34 cylinders of hydrogen.

These economies depend on one thing – the application they get in *your* plant. And that's where Armour comes in.

The men of our Technical Service Department are qualified to speak with authority on almost any problem of ammonia installation. Their wide experience has provided them with answers to all the common problems, as well as the most difficult installations.

If you are now using hydrogen in your plant and would like to investigate the advantages of ammonia dissociation, your nearest Armour salesman will be glad to help you with your problem. Or the Technical Service Department – as near as your mailbox – will give your questions prompt and thorough attention. Write today and tell us about your problem – also send for one or all of the booklets offered in the coupon.

You can depend on Armour's Ammonia and Service

ARMOUR *Ammonia Division*
Armour and Company, 1355 W. 31st St., Chicago 9, Ill.

CLIP AND MAIL THIS TODAY!

Please send me copies of the following booklets:

☐ "Applications of Dissociated Ammonia" ☐ "The Nitriding Process"
☐ "Ammonia Installations for Metal Treating" ☐ "Carbonitriding"

Name _____ Title _____

Firm _____

Address _____

City _____ Zone _____ State _____

Factors Influencing Structure of Electrodeposits

(Continued from p. 108)

cathode surface and that this film is thicker on the high spots and projections than in the recesses or low spots; and accordingly, current is diverted from the high to the low spots which receive extra deposit until a level surface is developed. In support of this theory, Gardam states that bright-nickel plating baths have a strong "smoothing action", that is, the surface of the deposit is smoother than the basis metal surface.

Simultaneous deposition of two metals is possible whenever their ionic concentrations can be so adjusted that their single electrode potentials are the same. Use of compounds like cyanide, which form complex ions, makes this possible in almost all cases. The structure of alloy deposits is characterized by very fine grain size.

Considerable X-ray diffraction work has been done on brass deposits of different compositions and all of the phases occurring in thermal alloys have been detected in deposited alloys. The phase boundaries, however, do not always agree, and the discrepancies, which may be of the order of 4% for a certain phase, make it appear that the deposited metal is in a form unstable at room temperature.

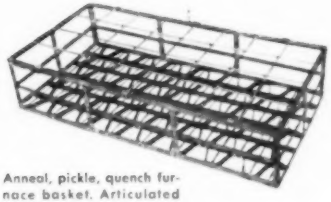
A very interesting alloy deposition is that of tungsten with iron, cobalt and nickel. These alloys, like their thermal counterparts, are age hardening, but the interesting point is that the deposited forms do not require a solution treatment because the minor constituent is already in solution. This is another example of the deposited alloy being in a "high temperature" or metastable form. Literature contains several similar instances: thus, a 2.6% copper-tin alloy has been plated as a solid solution, whereas it should be duplex; and a metastable 5.2% tin-lead solid solution has also been deposited. This phenomenon is not confined to alloys but occurs also with allotropes of pure metals. The metastable gamma manganese can be deposited under certain conditions instead of the stable alpha form. No serious attempt seems to have been made yet to explain these occurrences.

Cobalt can be deposited in two forms, and it has been understood for years that chromium possesses

(Continued on p. 112)

ROLOCK

FABRICATED ALLOYS

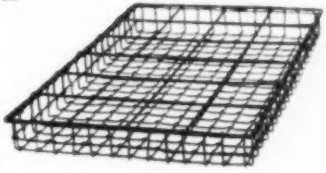


Anneal, pickle, quench furnace basket. Articulated "Serpentine" grid (pat. applied for), removable work dividers. Wt. 70 lbs., load 330 lbs.... ratio about 5 to 1.

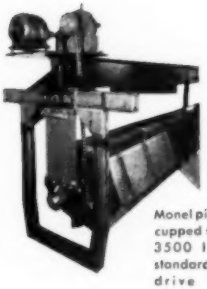
Pit type furnace basket for heat treating shell cases. Two layers of shells, mesh separator. Basket has loose shell, easily replaced. Fabricated grid, long life.

Monel pickling rack designed for 2000 lb. load in 8% H_2SO_4 at 165° F. Wt. 500 lbs., ratio 4 to 1.

MINIMIZE REJECTS
CUT COSTS
IN ORDNANCE
HEAT TREATING
..PICKLING



Lock-crimp, woven wire shell case basket, flat bottom, travels on rolls, either direction. Anneal and pickle. Wt. 54 lbs., load 350 lbs., ratio 6½ to 1.



Monel pickling barrel for cupped steel parts. Load 3500 lbs. Low H.P. standard speed motor drive thru bronze sprocket and chain.

New Catalog shows many exclusive designs produced for leading metal working plants. Copy on request.

Offices: PHILADELPHIA, CLEVELAND, DETROIT, HOUSTON, INDIANAPOLIS, CHICAGO, ST. LOUIS, LOS ANGELES, MINNEAPOLIS, PITTSBURGH

ROLOCK INC. • 1222 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

Kemp Immersion Melting Pots won't CRACK or BREAK

Save up to 40% on fuel with greater heating surface, faster heat recovery

More and more plants depend on Kemp Immersion Heating for *continuous, trouble-free* performance. Kemp pots, unlike underfired pots, can be used steadily in annealing, coating, tempering, descaling, etc. ...without the threat of *periodic* and *expensive* shutdowns for breakage. And each new Kemp installation means you eliminate costly temperature override, dangerous open flame fire hazards and the clutter of unsightly external pipes and ducts.

EFFICIENCY WITH ECONOMY

With Kemp Immersion Heating, you are assured maximum melting or heating efficiency... *plus* an estimated savings in fuel of up to *40% and more.* Thanks to Kemp engineering, these savings are built into every unit. You get greater heating surface, faster heat recovery, lower dross formation, even lower room temperatures. There's no brickwork to steal heat . . . no external combustion chamber . . . no carbon monoxide. You're money ahead when you switch to Kemp.

EASY TO USE, EASY TO MAINTAIN

The Kemp Carburetor, part of each installation, delivers complete combustion... without waste... without tinkering. One-pipe air and fuel feed reduces installation costs, simplifies maintenance. Kemp service also includes a staff of trained technicians who are instantly available at all times.

KEMP OF BALTIMORE — **IMMERSION MELTING POTS**

for technical information and facts on how we can help you cut your melting costs, write:

THE C. M. KEMP MFG. CO.
405 E. Oliver St., Baltimore 2, Md.

CARBURETORS • BURNERS • FIRE CHECKS • ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS • METAL MELTING UNITS • SINGEING EQUIPMENT • SPECIAL EQUIPMENT

Factors Influencing Structure of Electrodeposits

(Continued from p. 110)

a hexagonal modification in addition to the normal body-centered cubic form. Recently, however, it has been suggested that the hexagonal modification is really a hydride. In addition, a further type of lattice, face-centered cubic, has been produced under certain plating conditions. This is believed also to be a hydride. Both these types revert on heating to the body-centered cubic form.

Abnormalities and defects consist of nodules, trees, pits, blisters, cracks and burned and powdery deposits. Factors increasing the size and occurrence of nodules are: *(a)* Increasing thickness of deposit (or plating time), *(b)* presence of suspended particles in the bath or foreign matter on the cathode surface, *(c)* increasing current density. Nodules are often found on the edges and corners of thickly plated rectangular sheets, where the local current density is high.

There are two main types of trees, the difference between them being due to the type of bath. Copper that is deposited from an unbalanced cyanide copper bath results in the commonest form of treeing, which can be considered as a build-up by continual growth of small nodules one upon the other. In the other type of treeing, the trunk and each branch of the tree are single crystals. This structure is typical of lead and silver deposits obtained from certain types of solutions.

Chief causes of pits are: Presence of suspended matter in the bath; contamination on the surface of the article to be plated from an external cause or internal in origin as, for example, nonmetallic inclusions in steel.

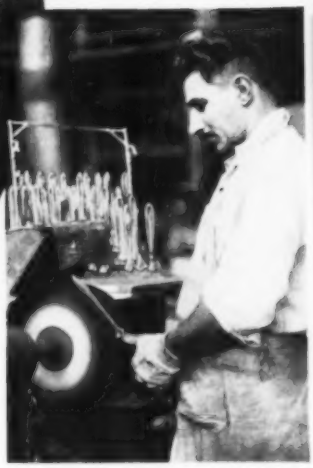
Most commercially troublesome pitting occurs in nickel deposits. It is usually ascribed to the action of a bubble of hydrogen, formed in the bath, adhering to the cathode surface and preventing deposition at the point of adhesion by denying access to the solution. Points at which hydrogen bubbles adhere are usually points where contamination is present.

Blisters nearly always occur over an area where adhesion is poor or nonexistent. The occurrence of cracking is confined to brittle deposits which are highly stressed. Burned and powdery de-

(Continued on p. 114)

ANOTHER CUSTOMER CONVINCED:

Formbrite *cuts polishing time in half*



Mirror handle sections are formed on a 400-pound drop hammer from blanks measuring 1⅝" x 8" x .032". Trimmed and soldered, the completed Formbrite handle requires only a light "color buffing" operation—accomplished in half the time previously required for ordinary drawing brass. Handle is soldered to etched mirror back and lacquered to retain its lustrous finish.

ASTORLOID Manufacturing Co., Inc., Bronx, New York, makers of dresser sets and cosmetic containers, asked us point blank: "Just what *is* Formbrite® . . . and what will it do for us?"

We explained that Formbrite is specially processed forming brass with such an exceptionally fine grain that buffing time is substantially reduced. It is stronger, "springier" and has a harder, more scratch-resistant surface than ordinary brass, yet is so ductile that it can be readily formed or drawn. Besides, it doesn't cost any more.

Astorloid's production engineers made a trial run of Formbrite in red brass alloy in their own press and polishing rooms and were amazed at the sharpness of the die impression . . . and at the bright lustrous finish which was obtained by a simple "color buffing" operation in half the time previously required.

Millions of pounds of Formbrite sheet, strip, rod and wire have been produced and satisfactorily fabricated into a wide range of products. We'd like to tell you more about the time and money-saving possibilities of this fine-grain metal . . . and send you a sample to try on your own polishing wheels. Address The American Brass Company, General Offices, Waterbury 20, Connecticut.

*Reg. U. S. Pat. Off.

Formbrite Drawing Brass is an

ANACONDA

PRODUCT

made by THE AMERICAN BRASS COMPANY

SOMEBODY pays for the scrap!

These screw machine parts, illustrated full size, are typical of the gas conversion appliances produced by Anderson & Forrester. Note the wide range of secondary machining operations necessary, such as slotting, milling and cross drilling. Some orifices require a No. 80 drill (.0135").

... and by scrap we don't mean the rod ends and chips incidental to screw machine operations — we mean the machined parts that, for one reason or another, wind up in the scrap bins instead of the shipping department. No one can speak with more authority than Anderson & Forrester, Denver, Colorado, manufacturers of gas jets, orifice caps, plugs, pilots and similar natural gas conversion appliances:

"We've been in business 25 years. We make hundreds of different screw machine products — millions of units a year — using over a million pounds of Anaconda Free Cutting Rods. We like these rods because we've always found them to be uniform in temper, dimension, machinability and over-all quality. Recently it was necessary to substitute some rods of a different make. Our operators spotted the difference immediately, complaining of 'hard temper,' excessive scrap and tool wear.

"We don't like to pay for scrap, nor can we pass along the cost to our customers. We depend on Anaconda Rods for the uniformity that gives us maximum tool life and permits us to duplicate standing records of speeds and feeds for long, uninterrupted production runs."

There are 46 Anaconda Copper and Copper Alloy Rods in a wide variety of commercial sizes and shapes suitable for screw machine use. Nineteen are free cutting alloys. Write for a copy of Publications B-14 and B-3, addressing The American Brass Company, General Offices, Waterbury 20, Connecticut.

ANACONDA

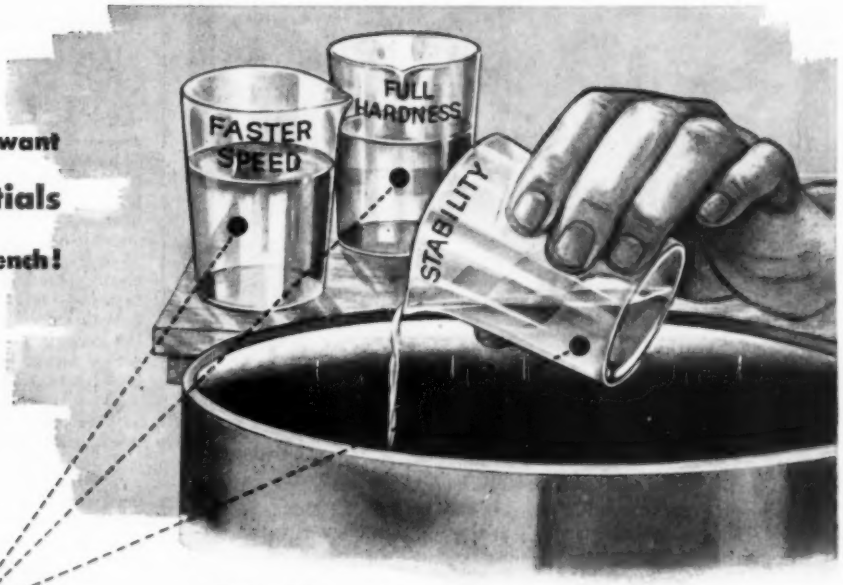
FREE CUTTING RODS

for top screw machine production

You want

3 Essentials

in every quench!



That's why

HOUGHTO-QUENCH

is ideal for heat treating "Lean Alloy" Steels

Get a *faster* quench through the critical zone. Meet high physicals safely with *full hardness*. Be sure of *uniform* quenching regardless of type of steel or temperature.

Use *Houghto-Quench*—the stable oil developed by Houghton to give you these three essentials in meeting critical quenching needs today.

Ask the Houghton Man to show you why Houghto-Quench gives you maximum hardness—even with present day low alloy steels. Or write to E. F. Houghton & Co., Philadelphia 33, Pa., for prompt information and prices.

ONE SOURCE FOR ALL NEEDS OF METALWORKING

Get "Liquid Salt Baths"—Houghton's latest booklet covering heat treating salts for carburizing, neutral hardening, annealing, tempering, martempering and other heat treating operations. Write to E. F. Houghton & Co., Philadelphia 33, Pa., or ask the Houghton Man.

HOUGHTO-QUENCH

. . . a product of

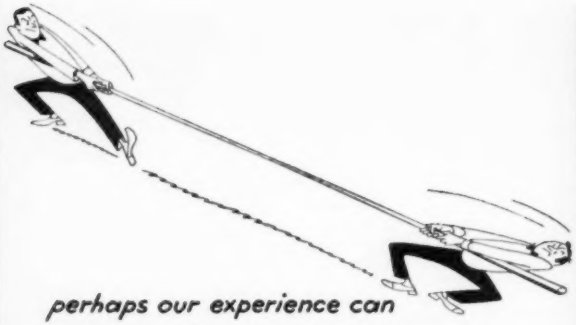
E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

OVER ONE HUNDRED YEARS OF CONTINUOUS SERVICE. ROUNDS, SQUARES, FLATS, HEXAGONS, OCTAGONS

BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS



perhaps our experience can

STRETCH

your alloy steel supplies!

You have doubtless heard about "bar-stretchers." Have you ever seen one? Wheelock, Lovejoy has several – any one of which can help you stretch your alloy steel supply so that you can keep up your production schedules during this period of unavoidable shortages. Having been in the steel business for over 100 years, our staff of metallurgists is in a unique position to help solve your difficulties. Our "bar-stretchers" include suggestions for substitute grades – alternate methods of manufacture – varying your present methods of treatment – and many more!

A letter or phone call to your nearest Wheelock, Lovejoy warehouse will bring an experienced man to help you stretch your alloy steel supply.

And he will be delighted to be of service! *SCRAP is worth money, and every pound turned in means more steel for you – so get in the SCRAP!*

Write today for your FREE COPY of the Wheelock, Lovejoy Data Book, indicating your title and company identification. It contains complete technical information on grades, applications, physical properties, tests, heat treating, etc.

WHEELOCK, LOVEJOY & CO., INC.

Warehouse Service

CAMBRIDGE • CLEVELAND
CHICAGO • HILLSIDE, N.J.
DETROIT • BUFFALO
CINCINNATI

In Canada
SANDERSON-NEWBOULD, LTD., MONTREAL

HY-TEN and AISI

134 Sidney St., Cambridge 39, Mass. and Cleveland • Chicago • Detroit Hillside, N. J. • Buffalo • Cincinnati

Factors Influencing Structure of Electrodeposits

(Continued from p. 112)

posits are among the effects of excessive current density.

Care must be taken in using brittle deposits in mechanical applications. Cracked, pitted and blistered deposits will be unsuitable for corrosion protection.

The generally finer grain size of electrodeposits and the presence of inclusions results in electrodeposits being harder and less ductile than the same metal in the cast or annealed forms. The relatively large changes in grain size which occur with change in plating conditions have been found to accompany even more striking changes in mechanical properties. Increases in hardness from 120 to 220 D.P.H. have been recorded for nickel deposits when the bath temperature was lowered from 175 to 85° F. An increase in the temperature of an acid copper plating bath from 75 to 105° F. is reported to have reduced the tensile strength of the deposit from 39,600 to 19,800 psi.

Laminations in deposits are often found to be planes of weakness which initiate failure when deposited metals are tested to destruction. The same applies to planes perpendicular to the cathode surface, which are formed by the junction of two crystal systems and which may contain included nonmetallic matter.

Effect of Hydrogen on Low-Alloy Steels*

HIGH-PRESSURE hydrogenizing is applied to some typical low-alloy steels (Cr, Ni, Mo) in a quantitative study of *(a)* hydrogen content, *(b)* effect upon mechanical properties, and *(c)* microstructural constitution. By utilizing pressures up to 120 atmospheres, hydrogenizing could be conducted at temperatures as low as 680° F. by injecting as much as 4 ml. per 100 g. of H_2, sufficient to cause severe embrittlement. This enabled controlled hydrogenizing at temperatures from 122 to 212° F. below the tempering range, such that the treatment did not alter the microstructure.

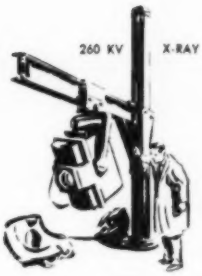
(Continued on p. 116)

*Abstract of "Effect of Hydrogen on the Properties of Low-Alloy Steels", by J. D. Hobson and C. Sykes, *Journal*, British Iron and Steel Institute, Vol. 169, November 1951, p. 209-220.

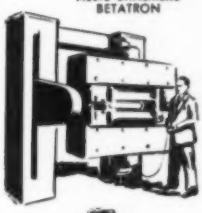
5 TO 50 KV INSPECTION UNIT

X-RAY DIFFRACTION UNIT

150 KV MOBILE X-RAY UNIT



260 KV X-RAY UNIT



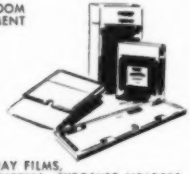
22,000,000 VOLT ALLIS-CHALMERS BETATRON

if it has to do

RAYPROOF RADIOGRAPHIC CABINET

RAYPROOF X-RAY INSPECTION CABINET

with X-RAY



DARKROOM EQUIPMENT

X-RAY FILMS, CASSETTES, EXPOSURE HOLDERS

CHEMICALS, ACCESSORIES, SUNDRIES

LAYOUT PLANNING

MAINTENANCE SERVICE

it has to do with

Picker x-ray

Picker *specializes* in x-ray, and x-ray only, covering the field like a blanket. *Whatever you need, we've got* . . . from a simple lead letter to a 22,000,000 volt betatron. To serve you, there are sales offices and service depots in all principal cities, staffed by skilled engineers prepared to cope with any x-ray problem promptly and with understanding. If you are now using x-ray, or are wondering whether you should, you can depend on Picker for objective technical counsel and efficient handling.

PICKER X-RAY CORPORATION | 25 S. Broadway, White Plains, N.Y.

SALES OFFICES AND SERVICE DEPOTS IN PRINCIPAL CITIES OF U.S.A. AND CANADA

AMERICAN CHEMICAL PAINT COMPANY
AMBLER ACP PENNA.

Technical Service Data Sheet
Subject: RUST PROOFING WITH PERMADINE®

INTRODUCTION:

Ferrous metal parts that have been Permadized in a zinc phosphate chemical solution and then "sealed" with a rust-preventive oil such as "Granoleum" are effectively protected from rust-damage. In addition, if the surface is accidentally chipped or scratched, rusting is confined to the exposed area.

Rust proof coatings find many practical applications. During World Wars I and II most small arms were rust proofed by phosphate coating and impregnated with chromic acid and a rust preventive oil, or cutback petrolatum. This not only provided excellent corrosion resistance but also yielded a dull black non-reflecting surface. Rust proof finishes are now used widely on hardware, firearms, cartridge clips, metallic belt links, miscellaneous forgings and castings, tools, unpainted replacement machine parts, and many other similar items such as bolts, nuts, and washers.

THE PERMADIZING PROCESS:

For the most effective rust proofing of large or small work in large or small production, "Permadine" is used in tanks in an immersion process, with the bath heated to 190°-210°F., coating time 20 to 30 minutes. The coated parts are then rinsed in clean water, and then in a controlled dilute acidulated solution. After drying, a suitable corrosion-resistant oil such as "Granoleum" is applied.

Operations can be carried out with the work in crates, or hung from hooks, utilizing an overhead rail and hoists. For large volume production, automatic equipment can be used to mechanize the line. Small parts can be treated in tumbling barrels.

"PERMADINE" MEETS SERVICE SPECIFICATIONS:

The protective "Permadine" finish meets U.S.A. 57-0-2C; Type II, Class B, and equivalent requirements of:

MIL-C-16232,
Type II
U.S.A. 51-70-1,
Finish 22.02, Class B
AN-F-20
Navy Aeronautical M-364
JAN-L-548

"PERMADINE" DATA CHART

Type of coating	Zinc phosphate
Object of coating	Rust and corrosion prevention
Typical products treated	Nuts, bolts, screws, hardware items, tools, guns, cartridge clips, fire control instruments, metallic belt links, steel aircraft parts, certain steel projectiles and many other components
Scale of production	Large or small volume; large or small work
Method of application	Dip Barrel tumbling, racked or basketed work
Equipment notes	Immersion tanks of suitable capacity. Cleaning and rinsing stages can be of mild steel. Coating stage can be of heavy mild steel or stainless steel.
Chemicals required	"Permadine" No. 1
Pre-cleaning methods	Any common degreasing method can be used. Alkali cleaning ("Ridosol"), Acid cleaning ("Deoxidine"), Emulsion-alkali cleaning ("Ridosol"-"Ridoline"), vapor degreasing, solvent wiping, etc., are examples. Acid cleaning may need to follow other cleaning methods if rust or scale is present.
Bath Temperature	190° - 210°F.
Coating time	20 - 30 minutes
Coating weight range Mgs./Sq. Ft.	1000 - 4000
Technical Service Data Sheets	No. 7-20-1-2 T. M. No. 5

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "PERMADINE" AND YOUR OWN METAL PROTECTION PROBLEMS

CHEMICALS ACP PROCESSES

Effect of Hydrogen on Low-Alloy Steels

(Continued from p. 114)

Within 5 min. after quenching, the specimen was placed in a vacuum furnace for hydrogen analysis at 1200° F. (Newell technique, as modified by Wells and Barraclough). The authors recognize the importance of keeping this interval to a minimum, but they apparently take no further precautions.

Both tensile and impact tests are performed on treated and untreated specimens of standard dimensions, and some alternative methods for introducing hydrogen are also compared. The results, in accord with general expectation, show a maximum sensitivity to hydrogen embrittlement for the condition of maximum hardness — "maximum stress" in the authors' terminology. However, a novel observation is that of a sharply defined optimum tempering temperature. That is, susceptibility decreases with increasing tempering, up to a point where the tendency reverses.

True stress-strain curves are found to be identical with or without hydrogen *up to the point of fracture*. The principal action of hydrogen is to defeat striction, or necking, and to cause fracture before the true maximum stress is reached. Hydrogen tends to increase the apparent maximum stress, but the loss in ductility overcompensates to produce a loss in true maximum stress. Similarly, the ultimate tensile strength as commonly reported on the basis of original area is unaffected by hydrogen, whereas the true stress is considerably reduced. As for notch-impact strength, hydrogen has certain marked effects, but decreased ductility is considered to be the more dependable measure of embrittlement.

Remarks arousing one's curiosity: The authors relate a condition of "woody" fracture to increasing H_2 content. Many years ago there was some confusion between woody fracture and flakes, but it is now generally presumed that woody fracture is a function of intergranular nonmetallics, often deriving from the ingot structure. Supervenient hydrogen might disclose a "woody" condition, but can it be a cause? Also, it is interesting to find that the authors choose 18-8 stainless steel for their furnace tubes because " . . . an austenitic steel is essential . . . to minimize hydrogen losses by diffusion through the

(Continued on p. 118)

MAXIMUM SHOCK RESISTANCE

MOST ECONOMICAL UNIT COSTS

LARGE QUANTITY PRODUCTION PER TOOL

BETTER RESISTANCE TO WEAR AT HIGH TEMPERATURE

MAXIMUM HARDNESS

HOLD CLOSE TOLERANCES LONGER

GREATER RESISTANCE TO ABRASION

LONGER RUNS WITHOUT RESHARPENING

MEET N.P.A. REQUIREMENTS

THE *RIGHT GRADE* OF . . .

Firth Sterling "MOLY" HIGH SPEED STEEL

can handle many jobs

BETTER . . . FASTER . . . CHEAPER

There is a Firth Sterling high speed steel for every purpose . . . whether high speed cutting, holding close tolerances, machining abrasive material, general shop work, or specialized application.

The *right* steel will increase production, reduce down-time and save many times the actual cost of the steel.

Choose the RIGHT STEEL

SEND FOR THESE HELPFUL BULLETINS

CIRCLE M	An 8% cobalt moly steel possessing great cutting capacity, unusual RED-HARDNESS value, and toughness.	For complete information on Circle M, ask for Bulletin SL-2032.
NEW VAN M 3 CHIP	Its higher vanadium and carbon content combine to produce superior WEAR-RESISTANCE . . . ideal for cutting hard materials . . . and for holding close tolerances.	For complete information on Van-Chip, ask for Bulletin SL-2033.
STAR-MO ★	A moly-tungsten steel recommended for GENERAL MACHINING operations.	For complete information on Star-Mo, ask for Bulletin SL-2015.
HI-MO	A made-to-order steel for SPECIAL PURPOSE applications.	Complete information about Hi-Mo will be furnished upon request.

Firth Sterling

FIRTH STERLING STEEL AND CARBIDE CORPORATION

GENERAL OFFICES: MCKEESPORT, PENNSYLVANIA

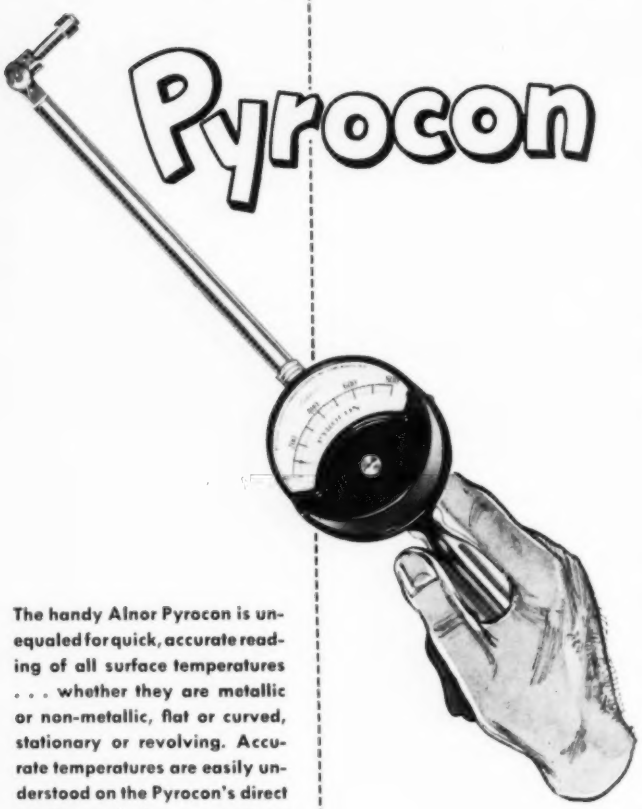
OFFICES* and WAREHOUSES:

Hartford New York* Philadelphia* Pittsburgh* Birmingham* Dayton* Cleveland Detroit Chicago Los Angeles

R-256

Take surface temperatures quickly, accurately... with the

Pyrocon



The handy Alnor Pyrocon is unequaled for quick, accurate reading of all surface temperatures . . . whether they are metallic or non-metallic, flat or curved, stationary or revolving. Accurate temperatures are easily understood on the Pyrocon's direct reading scale face . . . without interpolation or need of conversion tables. A wide selection of thermocouples and extension arms permits adaptation to many types of service. For complete details and prices, send for Bulletin No. 4257. Illinois Testing Laboratories Inc., Room 523, 420 N. LaSalle Street, Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

Effect of Hydrogen on Low-Alloy Steels

(Continued from p. 116)

heated tube walls." They do not state whether they reach this conclusion by test or by presumption, but the known greater solubility of hydrogen in austenite would ordinarily indicate just the opposite choice.

C. A. ZAPFFE

Chromium Impregnation of Carbon Steel*

CHROMIUM IMPREGNATION OR chromizing of carbon steel has been discussed in many previous papers but there has been little published information covering the mechanism or kinetics of chromizing. The present paper reports experiments designed to establish the reactions that actually occur and to indicate the factors that control the rate of chromizing.

Specimens from a sheet of mild steel (0.10 C, 0.05 S, 0.05 P, 0.10 Si and 0.21% Mn) were chromized in these experiments by two methods. The first consisted of generating a chromizing atmosphere from liquid chromous chloride at 1830° F. The chromous chloride vapor was passed over the specimens using the desired carrier gas which was made up of various mixtures of hydrogen and nitrogen. In the second method of chromizing, the chromizing atmosphere was generated by the reaction of chromium metal with hydrochloric acid.

The chromized coatings had a thick outer layer of columnar alpha crystals and a very thin inner layer of transformed gamma alloy. This coating structure is similar to chromized coatings reported in other investigations using the liquid salt bath process. The coatings had a chromium content of 18.5 to 22.8%, with a mean of 20.0%. These coatings were produced by treatments of 2 to 15 hr. at temperatures of 1780 to 1920° F. There was no correlation between the mean chromium content and either the time or temperature of treatment.

Preliminary experiments using mixtures of hydrogen and nitrogen as a carrier gas indicated that chro-

(Continued on p. 122)

*Abstract of "Mechanism and Kinetics of the Chromizing of Mild Steel in Atmospheres Containing Chromous Chloride", by T. P. Hoar and E. A. G. Croom, *Journal*, British Iron and Steel Institute, Vol. 169, October 1951, p. 101-107.

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Users Pick A-H5 in Survey of Air-Hardening Steels

Several years ago we had to make up our minds whether we were going to continue to promote the 2 pct chromium type of air-hardening tool steel or the newer 5 pct chromium type. Both are general-purpose die steels. In other words, plenty of wear-resistance is a must — plus sufficient shock-resistance for cold work.

The big question was to decide which was more important — the lower annealed hardness and easier machining of A-H5 (the 5 pct chromium steel) or the lower quenching temperature of the 2 pct chromium type.

We made an investigation among major users of tool steel, heat-treaters, and others. And here's what we found they wanted most, in order of importance:

1. Maximum wear
2. Minimum distortion in heat-treatment
3. Easy machining
4. Adequate shock-resistance
5. Low quenching temperature

It was a clear-cut vote for A-H5. And when the question of shock-resistance was discussed, they agreed, "If it's a shock job, then use a regular shock tool steel like Bethlehem Omega or 67 Chisel."

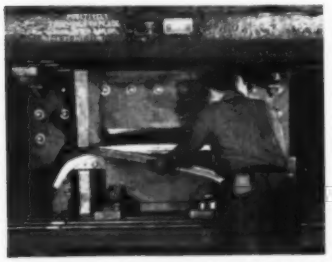
Our decision to carry rather complete stocks of A-H5 has been fully justified by the swing to the 5 pct chrome grade. We've watched A-H5 reach a new high in popularity for jobs that call for safe hardening, very little distortion, and high wear-resistance.

Users say:

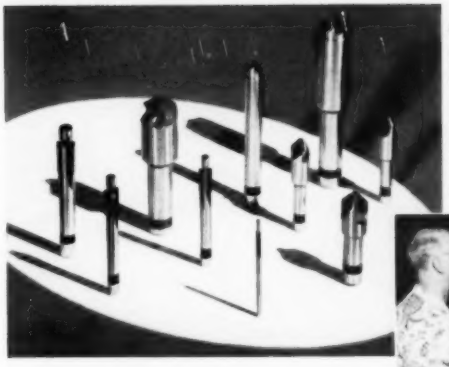
"... Never had such fine service from dies."

"Don't know what it is to have cracked dies any more."

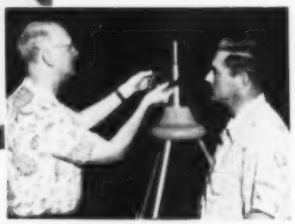
"... I've cut my costs on grinding and stoning many times since using A-H5."



Edges stay sharp on this trimmer die of A-H5 which removes ragged metal from sheet-steel parts.



These precision cutting tools are made from Bethlehem 66HS, our moly-tungsten high-speed steel. The CTC trademark appears in the undercut bands on the shank of each tool.



Final dimensions are checked on a main rotor balance stand for use by several helicopter manufacturers. Built by Custom Tool, this special fixture has a tip made of Bethlehem 67 Chisel tool steel.

Custom Tools made from Standard Tool Steels

It takes a variety of Bethlehem tool steels to meet the needs of Custom Tool Co., North Hollywood, Calif. Makers of special tools, especially those required in aircraft repair and assembly, this firm is the outgrowth of a home workshop where Ben Sprague, president of the company, began to make his own special tools to make the overhauling of aircraft an easier job.

Today the CTC trademark appears in the black band on the shank of countersinks, counterbores, hollow mills, special wrenches, fixtures and jigs. Quality steel and careful heat-treatment go hand in hand with the precision machining of tools made to close tolerances.

Here's a fine example of how many tool and die jobs are handled by standard tool steels. The CTC cutting tools are ordinarily made from Bethlehem Special HS, our standard 18-4-1 type of high-speed steel. But tungsten conservation measures now require the use of our moly-tungsten steel, Bethlehem 66HS.

Tools subject to heavy shock or impact loads are made either from Omega, our silico-manganese tool steel, or 67 Chisel, the chrome-tungsten type.

BTR, our manganese oil-hardening tool steel, was used recently by Custom Tool in a new series of screw gages which have been designed to set up standards for aircraft fasteners.

Our Tool Steel Engineer Says: Use extra care in quenching large sections of carbon tool steel

Large tools made of carbon tool steel can be cracked very easily during quenching. A quench which only partially hardens a tool made of carbon tool steel is more likely to cause cracking than a quench which produces full hardening.

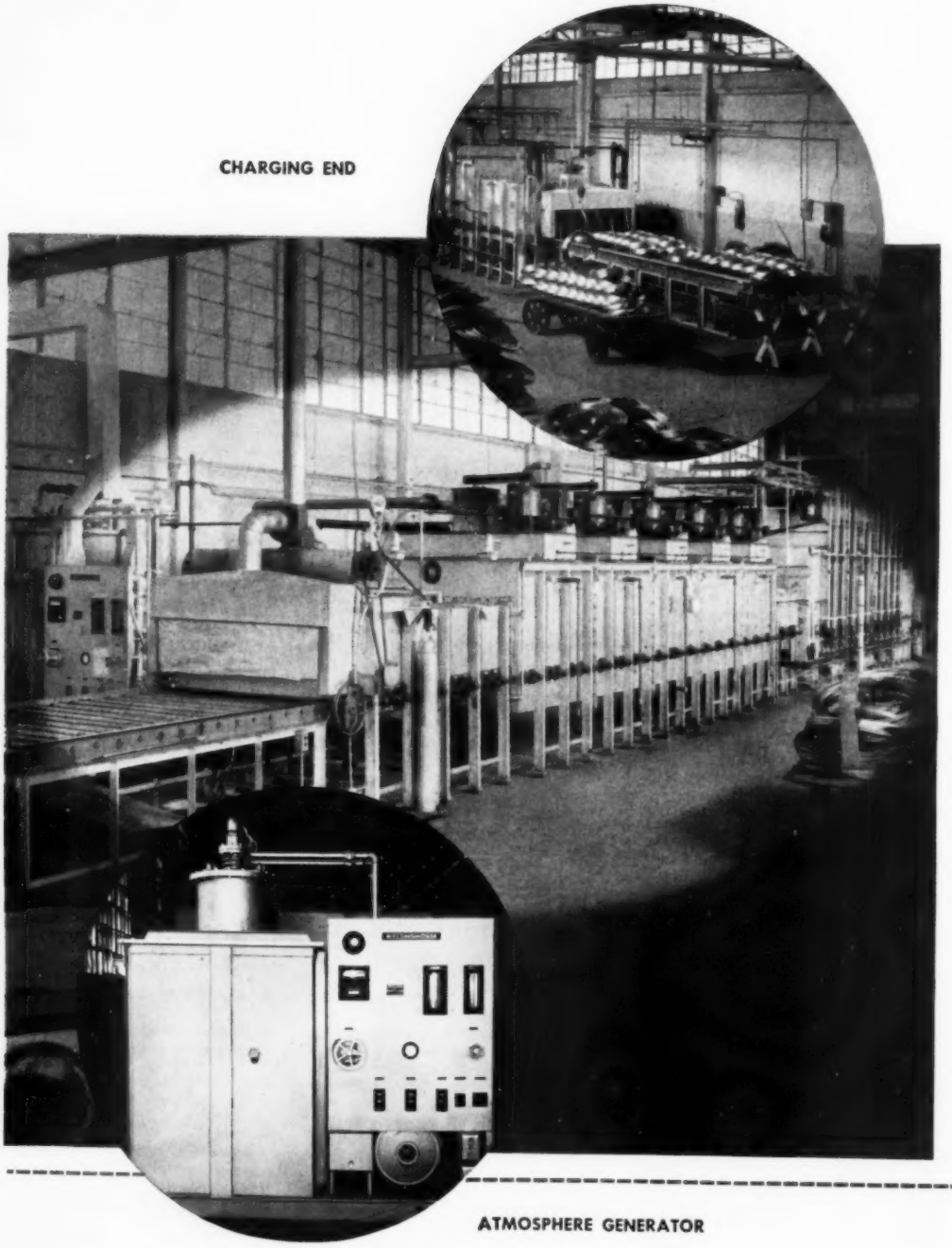
A quench which produces soft spots in the chill of carbon tool steel can cause cracking which is violent enough to be classed as an explosion — the tool may literally break up into a number of pieces.

Ineffective quenching which causes soft spots may result from:

Use of fresh water containing dissolved air ... use of water contaminated by soap, oil, etc. ... insufficient quantity of quenching solution ... inadequate agitation in the quench.

A drastic quench in brine which produces a uniform chill is necessary to avoid cracking large tools when they're made from carbon tool steel.

Bethlehem ULTRASONIC TESTED **Tool Steel**

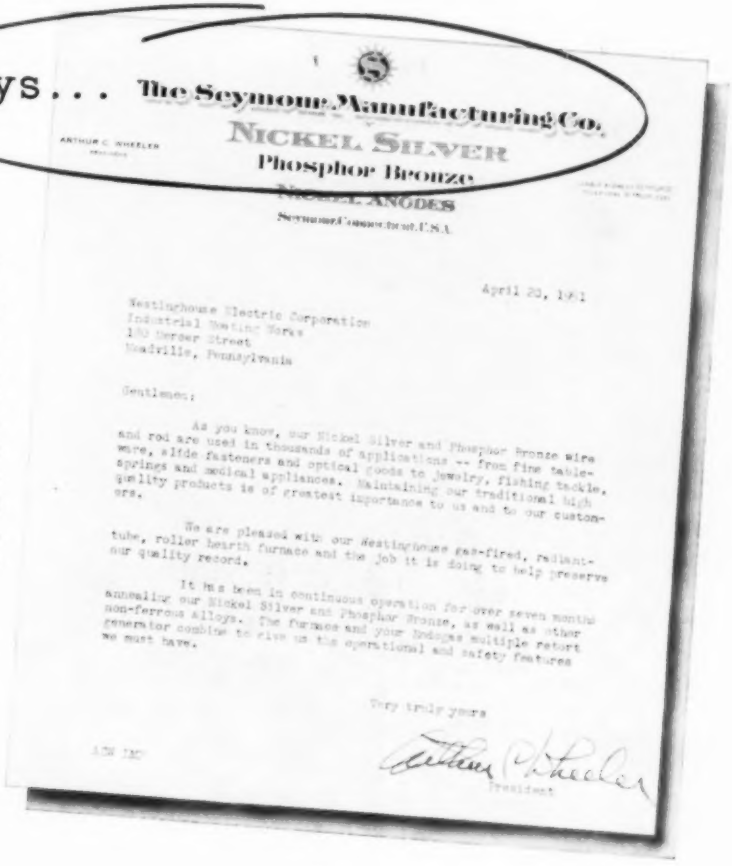


CHARGING END

ATMOSPHERE GENERATOR

"Gives us operational and safety features we must have"

says . . . The Seymour Manufacturing Co.


NICKEL SILVER
Phosphor Bronze
NICKEL ANODES
April 20, 1951
Westinghouse Electric Corporation
Industrial Heating Works
180 Mercer Street
Meadville, Pennsylvania
Gentlemen:
As you know, our Nickel Silver and Phosphor Bronze wire and rod are used in thousands of applications -- from fine tableware, slide fasteners and optical goods to jewelry, fishing tackle, springs and medical appliances. Maintaining our traditional high quality products is of greatest importance to us and to our customers.
We are pleased with our Westinghouse gas-fired, radiant-tube, roller hearth furnace and the job it is doing to help preserve our quality record.
It has been in continuous operation for over seven months annealing our Nickel Silver and Phosphor Bronze, as well as other non-ferrous alloys. The furnace and your Hydrogas multiple retort generator combine to give us the operational and safety features we must have.
Very truly yours
President

Gas-fired or electric, there's a Westinghouse Furnace to meet every heat-treating need. Select from a wide variety of standard units; or special designs can be prepared to meet particular needs. It's your assurance of an unbiased answer to your all-important problem. Westinghouse Electric Corporation, Industrial Heating Division, Meadville, Pennsylvania. J-10370

Westinghouse

HEAT-TREATING FURNACES

IF YOUR PRODUCT CALLS FOR HEAT-TREATING . . . IT CALLS FOR A WESTINGHOUSE FURNACE . . . GAS OR ELECTRIC

MERRILL
MATERIALS HANDLING
DEVICES

4 SIZES
LIFTING CLAMP
TWIN LIFTER
HAND GRIP
DRUM TILTER
4 SIZES
DRAG CLAMP
DRUM OPENER
3-M-1

MERRILL BROTHERS
56-31 ARNOLD AVENUE
MASPETH, N. Y.

Chromium Impregnation of Carbon Steel

(Continued from p. 118)

mizing was little affected by variation of the carrier gas between 100 and 67% hydrogen. The nitrogen-bearing carrier gases did result in a more uniform coating. The chromizing was irregular and slow in hydrogen-free nitrogen carrier gas. Pure hydrogen was used as the carrier gas in the main experiments. The chromizing rate showed no appreciable differences for gas flows from 183 to 610 cu.in. per hr.

The chromium uptake is always greater than the iron loss that would be expected in the interchange reaction $CrCl_2 + Fe \rightarrow Cr + FeCl_2$. The extra chromium evidently comes from the catalytic reduction, $CrCl_2 + H_2 \rightarrow Cr + 2HCl$, taking place on the metal surface. The chromium uptake and iron loss ratio of the interchange reaction is approximately equal to one. Therefore, the gain in weight of chromized specimens is equal to the weight of chromium formed by the reduction reaction.

These experiments showed that chromium uptake was proportional to time of treatment for short times, but that the relationship became roughly parabolic for longer treatments. It was concluded that the rate of chromium uptake at the beginning of chromizing is limited by the rates of the interchange and reduction reactions; in the later stages, the uptake is limited by the rate of interdiffusion of chromium and iron which decreases with an increase of coating thickness. The chromium uptake also increases with increasing temperature, as shown by tests at 1780, 1830, 1920 and 2010° F.

The thickness of the coating is approximately proportional to the time of treatment in the early stages of chromizing and also becomes parabolic after 2 to 4 hr. The authors derived a formula based on Fick's law which indicated that the parabolic relationship would be expected. The thickness of the coating increased with increasing temperature. The apparent energy of activation for the diffusion process was 57 kg-cal.

The chromous chloride vapor generated from liquid chromous chloride had a relatively high partial pressure compared to the atmosphere generated from hydrochloric acid and chromium. The

(Continued on p. 124)

GIVE UP THE OLD "PACK" HORSE!
THERE'S FUSS AN' BOTHER WITH PACKING POWDER!
DELAWARE CONTROLLED ATMOSPHERE FURNACE IS SIMPLE TO OPERATE AND LOW IN COST!
HANDLES EVERY TYPE STEEL CARBON TO "HIGH SPEED" FROM 1200° TO 2800°F.
DELAWARE
THERE'S NO NEED TO PACK YOUR WORK WITH THE SIMPLE DELAWARE CONTROLLED ATMOSPHERE FURNACE. WORK COMES OUT SMOOTH AND CLEAN... WITHOUT SCALE OR DECARBURIZATION.

FURNACE DIVISION
DELAWARE TOOL STEEL Corp.
3301 MARKET ST., WILMINGTON 99, DELAWARE

SEND for Bulletin F-1. It gives the straight facts on simplified controlled atmosphere heat treating.

* * * STRAIGHT FACTS on Controlled Atmosphere are included in DELAWARE BULLETIN F-1.

Send for your copy today.

DELAWARE TOOL STEEL CORPORATION
WILMINGTON 99, DELAWARE

FROM Borneman & Peterson

SUBJECT CUTTING OILS

ANY tiny production improvement looks big when it can be multiplied by acres of machines. But even without that—in an average size screw machine products shop like Borneman & Peterson's at Flint, Michigan—the improvement effected with Cities Service cutting oil registered impressively.

"We were getting fair results," write Borneman & Peterson, "before ever talking it over with a Cities Service Lubrication Engineer."

But they did talk it over, and then tried out his recommendation on a regular job of cutting ½" x 1" slots in tough tool steel. At once, the use of Cities Service Chillo cutting oil notably improved product quality.

So..."We then tried using Chillo 10 on our threading machines, and found that not only do we get a better thread, but we have increased chaser life approximately 25%."

From there on, still more uses have kept turning up in this shop for Cities Service cutting oil, simply because it distinctly pays off...as it always does when a Cities Service Lubrication Engineer offers pinpointed lubricating recommendations. He draws on the c-o-m-p-l-e-t-e Cities Service industrial line, and on deep, wide experience. You can draw on *him* by writing CITIES SERVICE OIL COMPANY, Dept. C-20, Sixty Wall Tower, New York City 5.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

CUT YOUR ANALYSIS TIME

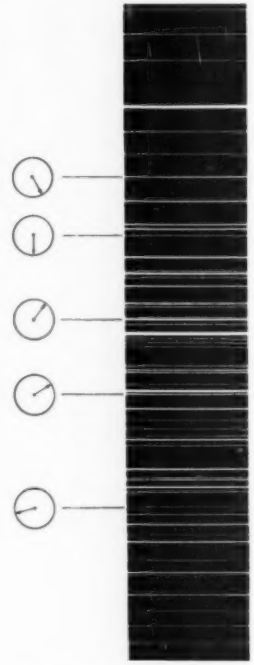
70% to 80%

with PUSH-BUTTON Spectrometry

How much is your furnace time worth? A minimum value in many metal-producing industries is $1 to $2 a minute.

How long does sample analysis take, by standard chemical means? An average value would be from 15 to 20 minutes per analysis, using established wet-chemical laboratory methods.

In a year, how much does this represent in $$$$$? Many producers run 7,500 to 10,000 heats during a year. With a standard analysis on each heat, this means a total cost of $112,500 to $400,000 a year, in furnace time effectively lost.



OF THIS TOTAL COST

$75,000 to $300,000

IS NEEDLESS WASTE

The Baird Associates-Dow Direct Reading Spectrometer permits a total analysis cycle — from furnace to laboratory to furnace correction — in about 5 minutes.

The "Direct Reader" is DIRECT — large clock-type dials indicate the percent concentration of each alloying element, in about 40 seconds after the single button control is pushed.

A complex analysis for 15 alloying elements takes no longer than a simpler analysis for 5 elements.

A conference with a Baird Associates engineer will be arranged at your request and convenience. Our new Bulletin #34, on Direct Reading Analysis, is furnished free to those who request it.

Baird Associates, Inc.

33 UNIVERSITY ROAD CAMBRIDGE 38, MASS.

Chromium Impregnation of Carbon Steel

(Continued from p. 122)

experiments showed that an increase in chromous chloride partial pressure increases the rate of chromium uptake and coating thickness in the early stages of chromizing but has no apparent effect when the coating has reached a thickness of 0.06 mm. The rate of metal interdiffusion limits the over-all rate when the coating thickness is over 0.06 mm.

This paper has shown that an increase in weight does occur when chromizing is done in a reducing atmosphere containing hydrogen. The increase in weight is explained by the catalytic reduction of chromous chloride by hydrogen. For thin coatings, the rate of production is very dependent on the environment so that the gas flow method is considerably faster than the salt bath process. For coatings of greater thickness, where the rate of chromizing is limited by the rate of metal interdiffusion, the method of chromizing will have negligible influence on the long times required.

The authors reached four conclusions, which are as follows:

"1. Mild steel (0.1% C) exposed to atmospheres containing chromous chloride at 950 to 1100° C. becomes coated with a chromium-rich layer produced by the interchange reaction $CrCl_2 + Fe \rightarrow Cr + FeCl_2$ and (when hydrogen is also present in the reagent atmosphere) by the reduction $CrCl_2 + H_2 \rightarrow Cr + 2HCl$, which proceeds catalytically on the growing surface.

"2. In the early stages of chromizing, the over-all rate of chromium uptake is constant with time and is limited by the rates of the interchange and reduction reactions — both of these reactions are increased by an increase of the partial pressure of chromous chloride in the atmosphere.

"3. In the later stages of chromizing, the over-all rate of chromium uptake diminishes with time according to a parabolic law; it is limited by the rate of the metal interdiffusion of chromium and iron, because this limits the concentration of iron in the growing surface available for interchange, and because the reduction is less well catalyzed by surfaces lower in iron.

"4. The apparent energy of activation for the metal interdiffusion process is 57 kg-cal."

R. E. Lochen

"ROCKWELL" HARDNESS TESTERS

See them in Action!

J-Model "ROCKWELL" HARDNESS TESTER

at the

ASTE INDUSTRIAL EXPOSITION

•

Chicago · Mar. 17 to 21

•

BOOTH 1126

TUKON TESTER for MICROHARDNESS TESTING

See how easy it is to be sure of the hardness of metal you process – by using WILSON Hardness Testing Equipment

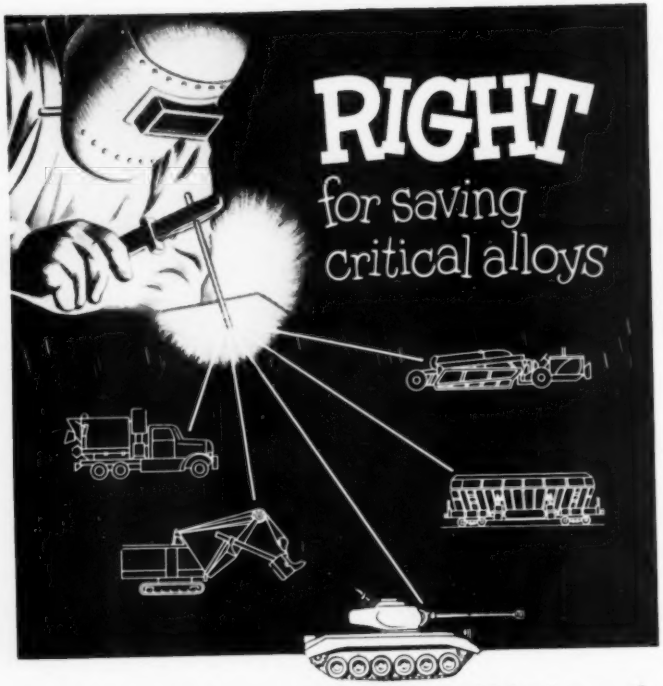
WILSON

"ROCKWELL" HARDNESS TESTERS

MECHANICAL INSTRUMENT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

230-F Park Avenue, New York 17, N. Y.



ARCOS Low Hydrogen Electrodes weld high tensile steel with savings in chromium and nickel

ARCOS LOW HYDROGEN ELECTRODES
Tensilend 70
Tensilend 100
Tensilend 120
Manganend 1M
Manganend 2M
Nickend 2
Chromend 1M
Chromend 2M

Time and service have proved the effectiveness of welding high tensile steel with Low Hydrogen Electrodes. And today's heavy demands for freeing critical alloys make their use more timely than ever before.

First developed in 1942, Arcos Low Hydrogen Electrodes are subjected to the same rigid quality controls as applied to its Stainless. That's your assurance of uniform, high quality weld metal for use on armor and other commercial applications. It means sound, dependable welds on every job, every time. Arcos offers the most complete selection of Low Hydrogen Electrodes in the field.

ARCOS CORPORATION • 1500 South 50th St., Philadelphia 43, Penna.

Write for new booklet "The ABC's of Welding High Tensile Steels"

WELD WITH ARCOS

Specialists in Stainless, Low Hydrogen and Non-Ferrous Electrodes

Resin Binders for Foundry Sand*

THE WRITER describes three types of resin used for binding core sand: p.f., or phenol-formaldehyde; u.f., urea-formaldehyde; and, m.f., melamine-formaldehyde. The modern types of mixers, especially the ultra-rapid, are as satisfactory for resin core sand as for oil sand. It is better to mix the dry ingredients first and then to add the liquids and again mix.

The importance of plasticity is emphasized, hence the use of water and cereal as well as resin. Some u.f. resins impart considerable green strength and need only small amounts of cereal or other specific green bonding agent to give the cores the required firmness and nonsagging properties. Other u.f. and most of the p.f. resins provide little or no green strength but do give greater dry strength. Increasing the moisture content and the amount of resin binder to some extent offsets the weakness of these resins. The green strength of the cores is between 1 and 3 psi. Most resin-bonded sands have good air-drying characteristics, permitting a lower initial green strength than would otherwise be necessary. Resin bonded core sands may be kept for several days if they are covered with a damp sack or cloth without significant change, providing no catalyst or hardener is used which is capable of causing condensation of the resin at shop temperatures.

A not uncommon standard of dry strength in a mechanized iron foundry may well be 1000 psi. in compression, 200 psi. in tensile, and 75 psi. for transverse. This thousand-fold increase over the strength of the "green" core is commonly achieved by baking in an oven to remove water, effect oxidation, polymerization, and other changes in the binder. It is in the development of this dry strength that synthetic resins show one of their major advantages.

The u.f. resins can develop "dry strength" without baking. A Swiss firm reports success in using u.f. and m.f. resins with a formic acid catalyst. Special drying ovens are eliminated (including cereal or other green bonding agents) because the cores may be left in the core box until the resin has hardened. A warning is issued in

*Abstract of "Synthetic Resins in the Foundry", by P. G. Pentz, *Metal Industry*, June 22, 1951, p. 504-507.

this connection concerning dermatitis, but on the whole this risk is not obviously greater than when oil binders are used.

All three resins respond very well to high-frequency drying, and overbaking is not possible. Optimum baking temperature is 350° F. for u.f. binders and about 425° F. for p.f., although 550° F. may be used if baking time is reduced.

Moisture content is very important; for example, by raising the moisture figure from 2 to 4%, the tensile strength is increased from 100 to 300 psi. All three resins impart good moisture resistance to cores.

Core strength is important during casting and it must be remembered that u.f. cores break down at a much lower temperature than p.f. cores. U.f. resins may be used for cross sections of 1 in. in nonferrous alloys, ¾ in. in gray iron and ½ in. in steel.

The finish of the casting made in resin bonded sand has been at least as good as that obtained from oil bonded cores.

H. J. Roast

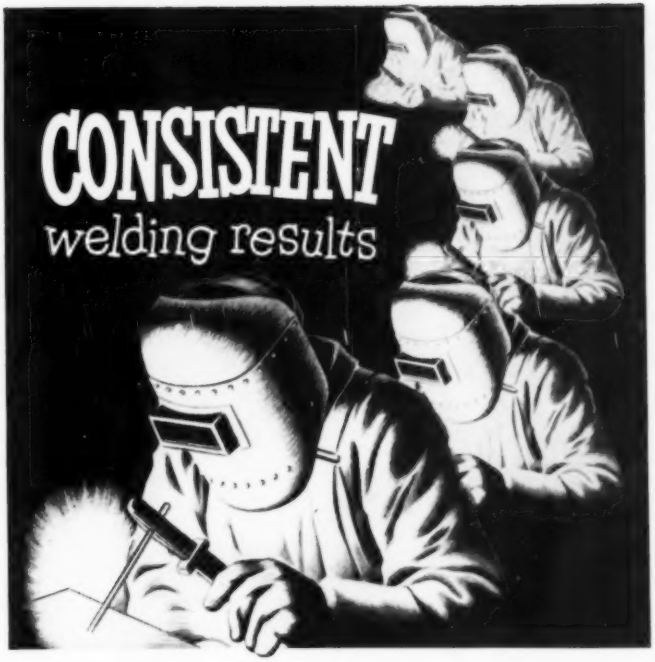
New Super-Alloys*

A tabulation of "critical" alloying metals required for jet engines emphasizes the fact that engine production may easily be limited by their availability. Furthermore, anywhere from half to four-fifths of these elements are contained in the scrap from manufacturing operations. One attractive approach to conservation is, therefore, to design and produce rough parts considerably closer to finished size.

For parts operating at temperatures less than 1000° F., low-alloy steels with proper surface protection may replace ferritic stainless compositions if creep values and resistance to stress corrosion of the alternates are sufficient. Structural brackets can be protected up to 450° F. by aluminum paints with silicone vehicle. Sprayed aluminum on 0.10 C steel is good up to 600° F., as on burner casings. Rotating parts requiring close dimensional tolerances can be cadmium plated for temperatures below the melting point of cadmium. Chromium and nickel plate "may seriously reduce the effective fatigue strength".

(Continued on p. 146)

*Abstracted from "Trends in Gas Turbine Engine Materials", by R. H. Thielemann, J. C. Mertz, and W. P. Eddy, Jr. (Pratt & Whitney Aircraft); paper for S.A.E. 1952 annual meeting.



ARCOS Stainless Electrodes assure you quality weld metal—easily deposited—time after time

You know the need today for producing sound, dependable welds on every job. It can mean savings in time, money and electrodes.

Benefits like these are yours with every box of Arcos Stainless Electrodes you receive. For each is backed by quality control tests more rigid than anywhere in the industry. That's why you can always count on Arcos for weld metal that is chemically, physically, and metallurgically of the highest type. It assures you of improved welding performance . . . more dependable results at lower weld costs.

ARCOS CORPORATION • 1500 South 50th St., Philadelphia 43, Penna.

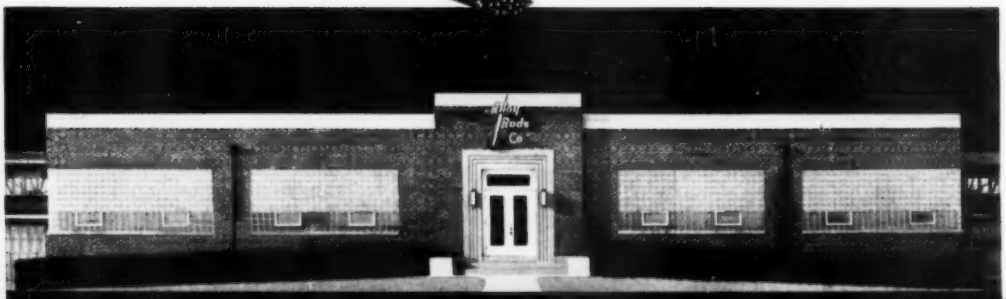
WELD WITH

ARCOS

Specialists in Stainless, Low Hydrogen and Non-Ferrous Electrodes

Naturally—

the world's finest alloy arc welding electrodes*



from the world's most modern alloy electrode manufacturing plant

AR-8

*ARCALOY for stainless steel • ARMORARC for armor welding • BRONZE-ARC for bronze and cast iron • NICKEL-ARC for cast iron • TOOL-ARC for tool steel • WEAR-ARC for hard-facing • WELD-ARC for low hydrogen electrodes.

Write for specific bulletins, or consult your Alloy Rods distributor.

Alloy Rods Co.

NO FINER ELECTRODES MADE . . . ANYWHERE **YORK, PENNSYLVANIA**

METAL PROGRESS

BULLETIN BOARD

THE BUYERS' GUIDE FOR METALS ENGINEERS

131 ABRASIVE PRODUCTS

131 135 CASTINGS

132 133 CLEANING & FINISHING

136 139 CONTROL INSTRUMENTS

134 135 HEATING EQUIPMENT

137 138 HEAT TREATING SERVICES

134 136 HEAT TREATING SUPPLIES

134 INDUCTION HEATING

139 140 INSPECTION EQUIPMENT

136 139 INSTRUMENTS & CONTROL

139 140 LABORATORY EQUIPMENT

142 METAL POWDERS

141 142 METALS & METAL FORMS

131 142 NONFERROUS METALS

132 133 PLATING SUPPLIES

141 PRESSES, METALWORKING

136 PYROMETER SUPPLIES

142 143 SPINNINGS & STAMPINGS

142 SPRING MATERIALS

141 142 STEEL & IRON

133 SURFACE PROTECTION

136 TEMPERATURE CONTROL

139 140 TESTING EQUIPMENT

139 TESTING SERVICES

141 TOOLS & TOOL STEELS

143 WELDING SUPPLIES

THESE ARE SOME OF THE THINGS A WELL-RUN EXPOSITION IN *YOUR* FIELD DOES FOR YOU!

- Brings your prospects to you
- Renews customer contact
- Enables you to actually demonstrate your products
- Establishes contact with people your salesmen can't reach
- Produces inquiries and leads
- Introduces new products quickly
- Opens new markets for you
- Builds sales organization confidence
- Establishes your firm
- Enables you to broaden your sales organization

Seeing is believing

There is no substitute for the actual demonstration of products to your prospective customer.

Buyers are people. They have the normal human instinct of wanting to see what they buy.

Photographs, literature, the most glowing description—by word of mouth or in print—can't quite do the same job of convincing the prospect as a first-hand inspection.

At the exposition which covers your industry or trade, more potential buyers can and do inspect the products of more exhibitors than they could possibly do in any other way in anything like the same time.

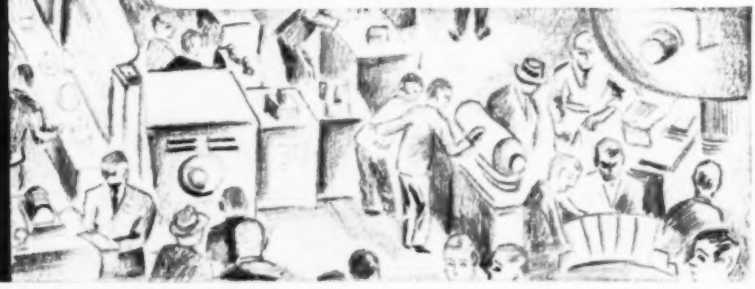
That is one of the many reasons why soundly operated expositions continue to grow in popularity and effectiveness for both 'sellers' and 'buyers'.

Are you exhibiting?

NATIONAL METAL EXPOSITION

October 20 thru 24, 1952

CONVENTION HALLS — Philadelphia, U.S.A.



THIS ADVERTISEMENT PREPARED BY NATIONAL ASSOCIATION OF EXHIBIT MANAGERS

Abrasive Wheels

MANHATTAN

Abrasive Wheels — Cut-off Wheels
Finishing Wheels—Diamond Wheels

Custom-made for your specific material removal problems

Foundry Snagging—Billet Surfacing—Centerless Grinding
Cutting and Surfacing concrete, granite, and marble
"Moldiscs" for rotary sanders
Grinding and Finishing stainless steel welds
Bearing Race Grinding and Finishing
Finishing Tools and Cutlery
Cutting-off—Wet or Dry Bars, Tubing, Structurals, etc. Foundry Cutting—standard and reinforced wheels
Grinding Carbide Tipped Tools

Write to Abrasive Wheel Department

Raybestos-Manhattan, Inc.
MANHATTAN RUBBER DIVISION
92 TOWNSEND ST. • PASSAIC, N. J.

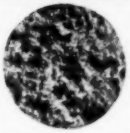
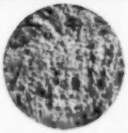
LIST NO. 1 ON INFO-COUPON PAGE 143

Notice

This Bulletin Board section of METAL PROGRESS brings you advertisements grouped according to products and services. Each ad carries a reference number at the bottom. Simply list this number on the coupon, page 143, and your requests for literature or other information will receive prompt attention.

Castings

Which is better for YOUR product?

NON-GRAN SAND CASTING	NON-GRAN CENTRIFUGAL
	

• *Request Booklet!*

American Non-Gran Bronze Co., Berwyn, Pennsylvania

NON-GRAN

LIST NO. 3 ON INFO-COUPON PAGE 143

EpCo

A PROVEN DEPENDABLE SOURCE
FOR BETTER GRADE INVESTMENT CASTINGS IN FERROUS AND NON-FERROUS METALS

INVAR CASTING Special Feature—Nickel content held to 35% minimum — 36% maximum

STAINLESS STEEL PART for milk bottling unit formerly machined from solid stock. Only finish operations required are reaming small dia. of counterbored hole and drilling and tapping for set screw.

ENGINEERED PRECISION CASTINGS CO.

MORGANVILLE, N. J.

LIST NO. 4 ON INFO-COUPON PAGE 143

IMPOSSIBLE?

NOW POSSIBLE
95-LB. PRECISION CASTINGS

Hastelloy, 316, 347, 410, 431 s.s. 4130, 4120, 1020, Copper, Aluminum

AN EXPERIENCED ENGINEERING STAFF AVAILABLE TO HELP WITH YOUR DESIGN PROBLEMS

INQUIRIES INVITED . . .
BROCHURE ON REQUEST

ALLOY PRECISION CASTING CO.
E. 45 ST. & HAMILTON • CLEVELAND, O.

LIST NO. 6 ON INFO-COUPON PAGE 143

RHODIUM Plating

In these days of restrictions on the use of the usual plating metals, the precious metal, rhodium, becomes important as a replacement for them, especially for small articles and parts.

Rhodium is hard and brilliantly white and it cannot tarnish. No acid nor mixture of acids attack it. Our solution has excellent throwing power.

Suggested objects for plating with rhodium are optical mounts, contacts for communication equipment, radar components, surgical instruments and pen and pencil sets. The practical plater's own experience will suggest many others to him.

Commercial rhodium plating was developed in our laboratories. Baker Rhodium Plating Solution is the original and is made under the direction of the men who developed the process.

● Let us send you *Directions for Rhodium Plating.*

Baker & Co., Inc.

113 ASTOR STREET
NEWARK 5, NEW JERSEY

LIST NO. 7 ON INFO-COUPON PAGE 143

NICKEL CHROME ALLOY DIPPING BASKET

Highest quality baskets ...strong, safe to handle. Mesh can be replaced when worn. Long life. Standardized for fabrication to any size. Send specifications to Dept. B.

(See our ad on Heat Treating Equipment in this publication.)

ROLOCK INC.
FAIRFIELD, CONN.

LIST NO. 8 ON INFO-COUPON PAGE 143

STEAM-JET SPEEDYELECTRIC CLEANER

Model JC-25

Helps 1 man do the work of 5

All-electric steam-detergent cleaning. For plant maintenance and industrial housekeeping. Pressures to 200 p.s.i. Other sizes available. *Write for bulletin 74-15.*

Livingstone Engineering Company
Manufacturers of Steam Generators
100 Grove Street • Worcester 5, Mass.

LIST NO. 9 ON INFO-COUPON PAGE 143

CIRCO VAPOR DEGREASERS *and* Metal Parts Cleaning Equipment

PER-SOLV (Perchlorethylene)
CIRCO-SOLV (Trichlorethylene)

Write for Bulletin

1681

TOPPER EQUIPMENT COMPANY
MATAWAN, NEW JERSEY
OFFICES IN PRINCIPAL CITIES
MANUFACTURERS OF VAPOR DEGREASERS AND METAL PARTS CLEANING EQUIPMENT

LIST NO. 10 ON INFO-COUPON PAGE 143

CLEANING EQUIPMENT and MATERIALS

DEGREASERS
•
METAL PARTS WASHERS
•
DEGREASING SOLVENTS
TRICHLORETHYLENE
PERCHLORETHYLENE
•
EMULSION and ALKALINE CLEANERS
•
RUST-PROOFING and PAINT-BONDING COMPOUNDS

DETREX CORPORATION
Box XVII Detroit 32, Michigan

LIST NO. 11 ON INFO-COUPON PAGE 143

SCRAPPY SAYS:

Nonferrous Scrap Is Needed Too

Solventol

originators of DI-PHASE metal cleaning

DESIGNERS & BUILDERS OF SPECIALIZED METAL CLEANING EQUIPMENT

LIST NO. 13 ON INFO-COUPON PAGE 143

NARACO RACKS with Replaceable Tips

Manufactured to exacting specifications for:

- ANODIZING
- PLATING
- PAINTING

and Conveyor Purposes.

AMERICAN RACK CO.
4632 West 21st Place — CICERO, ILL.

NATIONAL RACK CO., INC.
179-181 Madison Street — PATERSON N. J.

IMPERIAL PLATING RACK CO.
1613 Industrial Avenue — FLINT, MICH.

LIST NO. 14 ON INFO-COUPON PAGE 143

SEAL-PEEL COATINGS

PROTECT METALS AGAINST

RUST
CORROSION
SCRATCHES
ABRASION

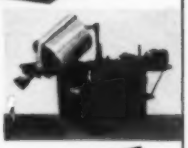
Extensive laboratory facilities are at your service for any rust, waterproofing, or corrosion-resistant problem.

Seal-Peel, inc.
11400 E. 9 MILE ROAD
VAN DYKE (DETROIT), MICH.

LIST NO. 16 ON INFO-COUPON PAGE 143

DANIELS

For economical bulk plating with fast loading and unloading features investigate the Daniels OLS Plating Barrels. Write for illustrated catalog today.



Now available, a new N series of Daniels Plating Barrels for low cost plating of small parts. Write for illustrated catalog today.

DANIELS PLATING BARREL & SUPPLY CO.

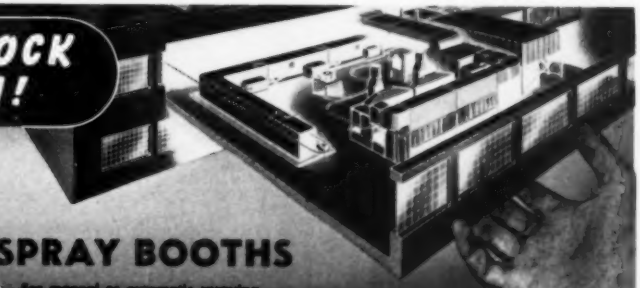
MANUFACTURERS and DISTRIBUTORS

Electroplating and Polishing Equipment and Supplies

129 Oliver Street • Newark 5, N. J.
Tel. MArket 3-7450

LIST NO. 17 ON INFO-COUPON PAGE 143

ROUND-THE-CLOCK PRODUCTION!



OVENS

Batch—Conveyorized.
Oil—Gas—Steam—Electric Heated.

WASHERS

Monorail—Belt Type.
Straight Run—Rotary—U-shaped.
Oil—Gas—Steam—Electric Heated.

SPRAY BOOTHS

For manual or automatic spraying.
All sizes and arrangements.
Also, Dip Tanks and Re-circulating Systems.

peters-dalton Inc.

17932 RYAN ROAD
DETROIT 12, MICHIGAN

LIST NO. 15 ON INFO-COUPON PAGE 143

SHERMAN

INDUCTION HEATING EQUIPMENT

Megacycle Tube Type Machines

Soldering • Brazing • Bombarding
Annealing • Hardening

Sizes: Standard—2,4,10,25 KVA; Custom—to 100 KVA

Fast • Powerful • Reliable

Challenge Comparison—Value • Quality • Price • Design • Appearance

Free Trial Run of Your Sample Parts

Complete data, application photos, prices, delivery in New illustrated Catalog. Write on your company letterhead.

Since 1930...Pioneers in Megacycle Heating

THOMAS REGISTER

SHERMAN *Industrial Electronics Company*

New York Area Office and Plant
505 Washington Ave., Belleville 9, N. J.

LIST NO. 18 ON INFO-COUPON PAGE 143

CIRC-AIR

HEAT TREATING FURNACES

for Every Heat Treating Process

★

CONTROLLED ATMOSPHERES

★

DIRECT FIRED

★

CIRC-AIR DRAW FURNACES

★

CIRC-AIR NICARB
(CARBONITRIDING)

Specially Engineered for Your Particular Needs

•

GAS • OIL • ELECTRIC

INDUSTRIAL HEATING EQUIPMENT

LIST NO. 19 ON INFO-COUPON PAGE 143

Upton *. . . offers*

THE MOST ADVANCED SALT BATH FURNACES FOR . . . .

Batch Type Work	*Conveyorized Type Work*

Upton Electric Furnace Co.
16808 Hamilton Avenue • Detroit, Michigan
Phone, Diamond 1-2520

LIST NO. 20 ON INFO-COUPON PAGE 143

ALWAYS SPECIFY THE BEST

Morrison

ENGINEERED

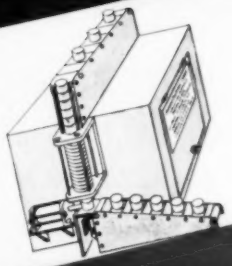
FURNACES	OVENS
ANNEALING	CORE BAKING
HARDENING	PAINT BAKING
TEMPERING	ROD BAKING
GALVANIZING	MOLD DRYING
NORMALIZING	LITHOGRAPHING
HEAT TREATING	ANNEALING
DRAWING & BRAZING	ARMATURE BAKING

Morrison ENGINEERING CORP
2222 FAIRHILL RD.
CLEVELAND 6, OHIO

LIST NO. 21 ON INFO-COUPON PAGE 143

MAGNETHERMIC

Low Frequency (60-cycle) Induction Heating



the production advantage you have been seeking

- ACCURATELY CONTROLLED HEAT
- UNIFORM HEAT THROUGHOUT PIECE
- NO WARM-UP TIME
- OPERATES ON STANDARD POWER SUPPLY
- COOL OPERATION
- AUTOMATIC LOADING AND UNLOADING
- MINIMUM FLOOR SPACE
- SIZES UP TO 20,000 LBS.
- EASY INSTALLATION—CONNECT POWER LEADS AND COOLING WATER, THAT'S ALL.

Prompt Answer to Your Inquiry

WRITE FOR ILLUSTRATED BULLETIN

60-CYCLE MAGNETHERMIC corporation
ANDREWS AVE. YOUNGSTOWN 1, OHIO
INDUCTION HEATING

LIST NO. 22 ON INFO-COUPON PAGE 143

HEAT RESISTANT CASTINGS

Whether you have a heating problem that involves heat resistant parts, take advantage of Standard's long experience in producing alloy castings engineered to your specific need. Conveyors, roller hearths, trays, containers, Exlonn radiant tube assemblies—and many more designs for a wide variety of applications are available.

* Consult the engineering representative nearest you—or write for the interesting 4-page Bulletin No. 7.

* BUFFALO
E. A. Mansfield
Ellicott Square

CINCINNATI
Pearson Browne
1st Nat'l Bank Bldg.

CLEVELAND
Alloy Sales & Service
Chas. Plant, Jr.
6905 Lake Ave., Rm. 303

DETROIT
Gehringer & Forsyth
16151 James Couzens Hwy.

HOUSTON
B. F. Coombs
2221 Telephone Rd.

LONGMEADOW, MASS.
B. G. Constantine
Control Engineering Co.
51 Converse St.

MILWAUKEE
Ed. P. Lindergren
3748 W. Greenfield Ave.

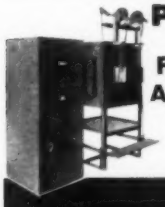
NEW YORK CITY
R. B. Steele
254 W. 31st St.

PHILADELPHIA
Towle & Son
18 W. Chelton Ave. Bldg.

PITTSBURGH
Robt. A. Schmidt
404 Frick Bldg.

STANDARD ALLOY CO., INC.
1679 COLLAMER ROAD • CLEVELAND 10, OHIO

LIST NO. 23 ON INFO-COUPON PAGE 143



PERECO
ELECTRIC FURNACES AND KILNS

PERENY EQUIPMENT COLUMBUS OHIO

Clean heat, accurately controlled. Wide choice of models for research, pilot plant, and production. Standard units for temperatures from 450° to 3000° F., or special research equipment up to 5000° F., to meet *your* needs.

WRITE FOR DETAILS TODAY
PERENY Equipment Co.
Dept. Q, 893 Chambers Rd., Columbus 12, Ohio, U.S.A.
EXPORT DEPT. The Inland Export Co., Inc. Greer Bldg., New Castle, Pa., U.S.A.

LIST NO. 24 ON INFO-COUPON PAGE 143

Non-Case

Anti-Carburizing Paint

Applied to any part of steel prior to carburizing, Non-Case protects that specific part from the absorption of carbon. Here is an invaluable coating that prevents carburization, or hardening, of certain spots or sections of steel parts. Easy to use, Non-Case is available in *quart or gallon cans.*

Write for Descriptive Literature

THE CASE HARDENING SERVICE CO.
3091 Mayfield Rd., Cleveland 18, O.

LIST NO. 26 ON INFO-COUPON PAGE 143

PORTABLE ELECTRIC OVENS

FOR THE METAL WORKING INDUSTRY

Standard Models for Every Special Need

LOW COST

Model HT-2
Max. Temperature 1000° F.
Approx. 4 cu.ft. working space.

220 Volt — 1 phase. Thermostat controlled. Can be used in groups or banks.

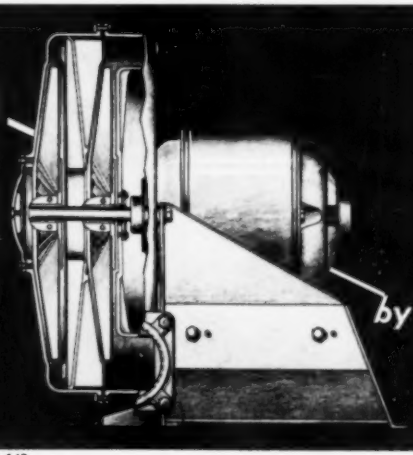
Standard models 225° F and up.

Write for full details.

GRIEVE-HENDRY CO., INC.
1646 W. Haddon St. • Chicago 22, Ill.

LIST NO. 27 ON INFO-COUPON PAGE 143

DESIGN



by North American Manufacturing Company
GAS OR OIL COMBUSTION EQUIPMENT
CLEVELAND 5, OHIO

LIST NO. 25 ON INFO-COUPON PAGE 143

FOR ALLOY CONSERVATION

USE

KASENIT

SURFACE HARDENING COMPOUNDS

- NON POISONOUS
- NON EXPLOSIVE
- NON INFLAMMABLE

★ Kasenit saves you money by simply and inexpensively providing controlled surface hardness on plain alloy and carbon steel parts. No scaling or warping. Try KASENIT now.

1-lb. Trial Size..... $2.00

KASENIT COMPANY
799 Greenwich St., DEPT. MP
New York 14, N. Y.
Established 1913

LIST NO. 28 ON INFO-COUPON PAGE 143

INSTRUMENTS AND CONTROL FOR HEAT TREATING FURNACES

A complete summary of Hays products applicable to processes such as annealing, brazing and calorizing. Scope includes various methods of firing (underfired, overfired, sidefired), fuel burned (gas, coal, oil), and type of furnace (continuous, rotary hearth, slab heating, etc.).

Hays complete line of draft gages, flow gages, and meters (for high and low pressure gases and liquids), portable gas analyzers and automatic CO_2 recorders are covered.

Send for Bulletin 49-750

THE HAYS CORPORATION
MICHIGAN CITY 26, INDIANA

LIST NO. 30 ON INFO-COUPON PAGE 143

Control Temperatures More Closely

REDUCE COST • SAVE TIME

This Catalog of Improved Pyrometer Supplies shows you how!

Get your FREE Copy Today!

★ Thermocouples ★ Protection Tubes
★ Thermocouple Wire ★ Lead Wire
★ Insulators ★ Terminal Heads

ARKLAY S. RICHARDS CO., Inc.
NEWTON HIGHLANDS 61, MASS.

LIST NO. 31 ON INFO-COUPON PAGE 143

Serving the
HEAT TREATING INDUSTRY
Since 1930

- Complete Service on Control Equipment
- Thermocouples
- Protection Tubes
- Charts and Lead Wire

THE CLEVELAND ELECTRIC LABORATORIES COMPANY

1988 E. 66 St.

Cleveland 3, Ohio

LIST NO. 32 ON INFO-COUPON PAGE 143

FREE
The Quenzine Story

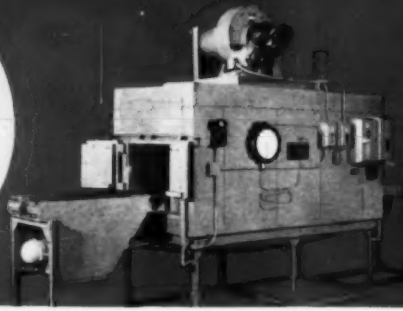
Low priced, more readily available carbon steels can often replace alloy steels when quenched in Beacon Quenching Oils with QUENZINE added. For information on this new additive and other Beacon Brand Heat Treating Compounds write to . . . .

Aldridge Industrial Oils, Inc.
3401 W. 140th St., Cleveland 11, Ohio

LIST NO. 29 ON INFO-COUPON PAGE 143

COMPLETELY AUTOMATIC HEAT TREATING OVENS AND FURNACES

Typical of many automatic and time-operated heating ovens and furnaces designed by Carl-Mayer, the pictured illustration conserves valuable man-hours. Conveyor and batch-type furnaces up to 2000° F., using gas, oil, or power, can be designed and built to meet your heating and processing problems.



CARL-MAYER CORPORATION
3030 EUCLID AVE.
CLEVELAND, OHIO

LIST NO. 33 ON INFO-COUPON PAGE 143

Diversified Heat Treating Facilities for . . .

STEEL • ALUMINUM • MAGNESIUM

FORGINGS · CASTINGS · TOOLS AND PARTS

Carbonitriding
Controlled Atmosphere
Cyanide and Neutral Baths
Liquid, Gas and Pack Carburizing
Induction Heating

•

Pit Type Convection Furnaces
Large Car Bottom Furnaces
Production Box Furnaces

Solution Heat Treatment
Hardening
Tempering
Normalizing
Annealing

•

Grit Blasting
Shot Blasting
Shot Peening

Our management, production and sales staff are all metallurgically trained. Their combined experience is available for complete heat treating counsel without obligation. •

Send for Free Booklet of Complete Facilities

Pearson INDUSTRIAL STEEL TREATING CO.
4747 West Harrison Ave. Chicago 44, Ill.

LIST NO. 36 ON INFO-COUPON PAGE 143

42nd YEAR

A VINCENT PROCESS For EVERY HEAT TREATING NEED

•

300-TON DAILY CAPACITY

•

MODERN FACILITIES

VINCENT STEEL PROCESS CO.
2424 Bellevue Ave. • Detroit 7, Mich.

LIST NO. 37 ON INFO-COUPON PAGE 143

HEAT TREAT at it's Best!

COMPLETE SERVICE including —
BRIGHT HARDENING OF STAINLESS STEELS...STEAM TREATING HIGH-SPEED CUTTING TOOLS ... HARDENING ... TEMPERING ... CLEANING.

Our Metallurgical Engineers can help with your metal treating problems.

COMMERCIAL STEEL TREATING CORP.
6100 Tireman Detroit 4, Mich.
TYler 6-6086

LIST NO. 39 ON INFO-COUPON PAGE 143

YOUR COMMERCIAL HEAT TREATER IN DETROIT

OFFERS FACILITIES FOR:

1. ALUMINUM - CAP. 500,000# PER MO.
2. MINUTE PARTS TO 2-TON DIES
3. BRIGHT HARDENING OF STAINLESS STEEL

•

ALL TYPES OF HEAT TREATING CAN BE DONE BY . . .

STANDARD STEEL TREATING CO.
3467 LOVETT AVE. DETROIT, MICH.

LIST NO. 40 ON INFO-COUPON PAGE 143

HEAT TREATING

3537 E. 16th Street
Los Angeles 23, California

650 East Taylor Avenue
St. Louis 15, Missouri

Lindberg Steel Treating Company is ideally equipped to serve you in any phase of the heat treating field.

- Located in four major industrial areas.
- Equipped to perform every process — from the most conventional to the latest and most difficult techniques.
- More than 25 years of experience in processing almost every conceivable type of metal part.
- Trained and experienced metallurgical engineers available for consultation at any time — just call or write.

Write or call for your copy of the illustrated booklet "Surface Hardening of Stainless Steel."

222 N. Laflin Street Chicago 7, Illinois

620 Buffalo Road Rochester 11, New York

LINDBERG STEEL TREATING CO.
222 N. Laflin Street, Chicago 12, Illinois Phone: MOnroe 6-3300

LIST NO. 38 ON INFO-COUPON PAGE 143

STEEL TREATING

• FLAME HARDENING
• CARBURIZING & HARDENING
• LIQUID • PACK • GAS
• SHOT BLASTING • ANNEALING
• TENSILE TESTING • NORMALIZING

HEAT TREATING & STRAIGHTENING OF BARS UP TO 22' LENGTHS

Established 1913

MEMBER AMERICAN SOCIETY FOR METALS

HEnderson 1-3837

THE W. S. BIDLE CO.

LIST NO. 41 ON INFO-COUPON PAGE 143

DON'T WAIT... COOPERATE!

The U.S. Needs Your Steel Scrap, Now

Nonferrous Scrap Is Needed Too

BRIGHT HARDENING and ANNEALING of STAINLESS STEEL

HEAT TREATMENT of ELECTRICAL ALLOYS

ATMOSPHERE CONTROLLED HEAT TREATING

and STANDARD OPERATIONS

DREVER CO.

HEAT TREATING DIVISION

224 CAMBRIA ST. PHILADELPHIA 33, PA.

LIST NO. 44 ON INFO-COUPON PAGE 143

Heat Treating OF METALS

Flame Hardening	Stress Relieving
Induction Hardening	Normalizing
Chapmanizing	* Gas, Pack or Liquid Carburizing
Nitriding	Annealing
* Cyaniding	Silver-Finish Hardening of Dies or Tools
Cadmium, Tin or Copper Plating	* Roto-Blasting
Anodizing or Alrocking of Aluminum	Silver or Copper Brazing

PITTSBURGH COMMERCIAL HEAT TREATING CO.

90 49th Street Pittsburgh, Pa.

LIST NO. 42 ON INFO-COUPON PAGE 143

Boron Steel

Just off the press . . . . a timely collection of eight articles on boron steel, reprinted from METAL PROGRESS.

Write now for your copy of this new publication. Price is $1.00.

•

American Society for Metals

7301 Euclid Cleveland

LIST NO. 43 ON INFO-COUPON PAGE 143

Scientific STEEL IMPROVEMENT

Our Services: Electronic Induction Hardening, Flame Hardening, Heat Treating, Bar Stock Treating and Straightening (mill lengths and sizes), Annealing, Stress Relieving, Normalizing, Pack, Gas, or Liquid Carburizing, Nitriding, Speed Nitriding, Aerocasing, Chapmanizing, Cyaniding, Dry Cyaniding, Sand Blasting, Tensile and Bend Tests.

THE *Lakeside Steel Improvement Co.*

3418 LAKESIDE AVE., CLEVELAND 14, OHIO HENDERSON 1-9100

METALS TESTING SERVICE

- CHEMICAL
- PHYSICAL
- SPECTROGRAPHIC
- RADIOGRAPHIC
- METALLOGRAPHIC

★ SPECIAL STUDIES WITH RADIOACTIVE TRACERS

• UNITED STATES TESTING COMPANY, INC.
ESTABLISHED 1880
1520 PARK AVENUE HOBOKEN, N. J.
NEW YORK • BOSTON • PHILADELPHIA • MEMPHIS • DALLAS
HOBOKEN • PROVIDENCE • CHICAGO • LOS ANGELES • DENVER

LIST NO. 47 ON INFO-COUPON PAGE 143

Solve INSPECTION DEMAGNETIZING SORTING PROBLEMS with MAGNETIC ANALYSIS EQUIPMENT

Electronic Equipment for non-destructive production inspection of steel bars and tubing for mechanical faults, variations in composition and physical properties. Average inspection speed 120 ft. per minute.

This Equipment is now employed by more than 40 Steel Mills and many Steel Fabricators.

MAGNETIC ANALYSIS DEMAGNETIZERS

Electrical Equipment for efficient production demagnetizing of steel bars and tubing. When used with Magnetic Analysis Equipment inspection and demagnetizing can be done in a single operation.

MAGNETIC ANALYSIS COMPARATORS

Electronic Instruments for production sorting of ferrous and non-ferrous materials and parts for variations in composition and physical properties.

ALSO MAGNETISM DETECTORS

Inexpensive pocket meters for indicating magnetism in ferrous materials and parts.

For information write "THE TEST TELLS"
MAGNETIC ANALYSIS CORP.
42-44 Twelfth St. Long Island City 1, N. Y.

LIST NO. 51 ON INFO-COUPON PAGE 143

MERIAM MANOMETERS

U-TYPE • WELL TYPE • DUAL TUBE

FLOW METERS
DRAFT GAUGES

For measuring pressure, vacuum and differential pressure of liquids and gases. Also a complete line of accessories.

ASK FOR CATALOG C-12

THE MERIAM INSTRUMENT CO.
10932 MADISON AVE.
CLEVELAND 2, OHIO

U-TYPE MANOMETER

LIST NO. 48 ON INFO-COUPON PAGE 143

Headquarters for
NON-DESTRUCTIVE TESTING
and
MEASURING INSTRUMENTS

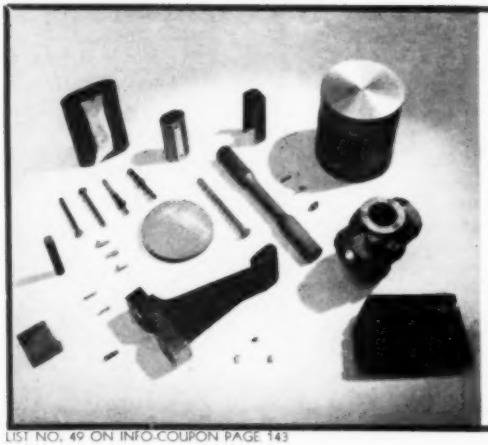
★ ★ ★

ULTRASONIC & MAGNETIC INSPECTION EQUIPMENT
Crack & Defect Locators
Metal Sorters
Ultrasonic Thickness Gages

ELECTRONIC MICROMETERS
For production measurement of precision components to within 0.000020 in.

J. W. DICE CO.
ENGLEWOOD, N. J.
SEND FOR BULLETIN 21

LIST NO. 50 ON INFO-COUPON PAGE 143



IF CONTROL OF THESE PARTS IS YOUR PROBLEM . . .

SPECTROSCOPY IS THE ANSWER!

Undivided responsibility for complete installation of all Spectrographic equipment.

NATIONAL SPECTROGRAPHIC LABORATORIES, INC.
6300 EUCLID AVENUE CLEVELAND 3, OHIO

LIST NO. 49 ON INFO-COUPON PAGE 143

FLASH-O-LENS Lights and Magnifies

METAL SURFACES FOR FAST, ACCURATE INSPECTION

Another FLASH-O-LENS at work—this time at Eastman Kodak Company!

You *too* can cut down inspection time and improve product quality by using this simple, handy, low-cost instrument that *spotlights* the work and *magnifies* it at the same time . . . the FLASH-O-LENS!

Just put a FLASH-O-LENS on the part you're inspecting. Built-in bulb puts light *on* the field of vision—keeps it *out* of user's eyes. Accurately ground lenses give sharply detailed enlargement. Result: time-and-eye-saving inspection, surer maintenance of quality standards.

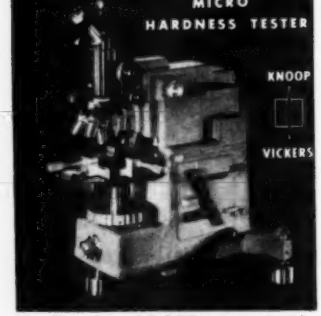
Battery-operated and plug-in models—$10.65 up. Write for literature on suggested applications, types and prices.

E.W. PIKE & COMPANY
492 NORTH AVE. ELIZABETH, N. J.

LIST NO. 52 ON INFO-COUPON PAGE 143

KENTRON

MICRO HARDNESS TESTER



Applies 1 to 10,000 gram loads

Write for Bulletin

KENT CLIFF LABORATORIES
PEEKSKILL NEW YORK

LIST NO. 53 ON INFO-COUPON PAGE 143

LABORATORY FURNACES

You tell Boder what you need

Boder Scientific Co.
719-723 Liberty Ave.
Pittsburgh 22, Pa.

BODER SCIENTIFIC PITTSBURGH

LIST NO. 55 ON INFO-COUPON PAGE 143

Use the BARBER COLMAN *Impressor*

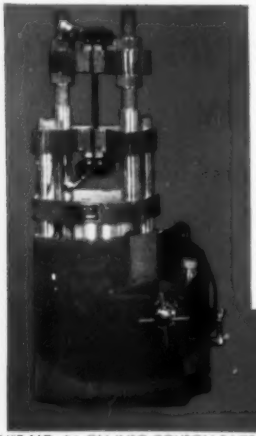
on ALUMINUM COPPER BRASS BRONZE and PLASTICS

for Fast and Efficient HARDNESS TESTING

Works on the principle of forcing a hardened, spring-loaded steel point into the surface, the amount of penetration registering instantly on a dial indicator to give a dependable measure of hardness. Operator simply places Impressor on surface and presses down firmly. Can be used in any position, even against edges or ends of pieces when stacked. Requires little effort, ideal for women inspectors. Strongly built for durability and consistent accuracy. Thousands in use. *Comes in velvet-lined, fitted wood case with extra point and full maintenance instructions.* Write for Bulletin E-1689-1.

BARBER-COLMAN COMPANY
1235 ROCK STREET • ROCKFORD, ILLINOIS

LIST NO. 56 ON INFO-COUPON PAGE 143



FAST ACTION

IN TENSILE AND BRINELL TESTING

Whether your testing problems involve the tensile strength or Brinell hardness of metals or component parts, Detroit Testing equipment will speed your operations. In fact, on any tests involving metals, consult Detroit Testing—or write for informative literature.

DETROIT TESTING MACHINE CO.
9390 GRINNELL AVENUE DETROIT 13, MICHIGAN

LIST NO. 54 ON INFO-COUPON PAGE 143

ARDCOR TUBING ROLLS

*PRODUCTION PROVEN — 30% More Footage!

These Tubing Rolls, made of ARDCORLOY* — a special alloy steel, were designed and manufactured by ARDCOR for one of America's leading Welded Tube Manufacturers (name on request).

What are YOUR Roll Forming Requirements?

ARDCOR ROLLER DIES • ROLL FORMING MACHINERY • CUT-OFF MACHINES

American ROLLER DIE CORPORATION
20680 St. Clair Avenue • Cleveland 17, Ohio

LIST NO. 57 ON INFO-COUPON PAGE 143

TOOL STEEL
NATIONALLY KNOWN BRANDS

BELOW MILL PRICES

- High Speed: T-1 to T-15, M-1 to M-56
- High Carbon—High Chrome
- Oil Hardening
- Air Hardening
- Water Hardening
- Hot and Cold Work-Die Steel
- Fast Finishing Steels

COMPLETE WAREHOUSE FACILITIES

MILL GUARANTEED

RELIABLE STEEL CO.

LIST NO. 61 ON INFO-COUPON PAGE 143

DRAWING STAINLESS?

Use . . .
Hangsterfer's
LUBRICANTS
for . . . Increased Production
Less Scrap
Longer Die Life

Doing the most difficult jobs for the major metalworking plants throughout the United States and Europe.

HANGSTERFER'S LABORATORIES, INC.
21 Cooper Street • Woodbury, N. J.

LIST NO. 73 ON INFO-COUPON PAGE 143

Darwin

PRK-33 — Air Hardening, Non Deforming, 13% Cr, 3% Co
NEOR — Oil Hardening, Non Deforming, 13% Cr, 2% C
MINEOR — Air Hardening, Non Deforming, 5% Cr, 1% Mo

DARWIN & MILNER INC.
Highest Grade Tool Steels
2345 St. Clair Avenue
Cleveland 14, Ohio

LIST NO. 60 ON INFO-COUPON PAGE 143

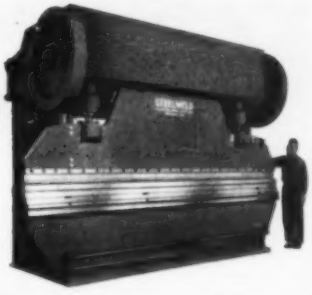
Corrugating and any straight-line production bending can be done to hairline accuracy.

Conical sections are quickly formed with standard bending dies by use of the ram-tapering mechanism.

STEELWELD BENDING PRESSES

Large holes can be punched singly. Smaller holes can be punched 25 to 150 at a time.

Steelweld Presses for bending, forming, blanking, drawing and multiple-punching operations. Complete line for all size metal to 1¼" x 20'-0". Write for free copy of catalog No. 2010.

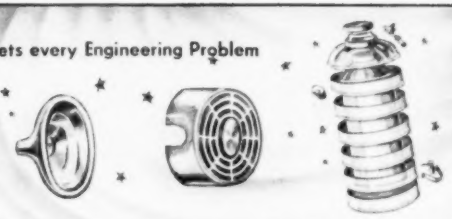


Steelwelds have heavy duty one-piece welded frames that stay rigid for life. Machinery is top quality throughout and easy to maintain.

THE CLEVELAND CRANE & ENGINEERING CO.
5941 East 281st Street • Wickliffe, Ohio

LIST NO. 59 ON INFO-COUPON PAGE 143

METAL
Spinning
Stamping
Fabricating
to the Industrial
Specifications
C. A. DAHLIN meets every Engineering Problem



IF it's intricate or simple...large or small production...
...any metal you name - *Investigate the C. A Dahlin facilities for dependable service and quality workmanship.*
Write today for the C. A. Dahlin Special Bulletin.

C. A. DAHLIN COMPANY
2729 CLYBOURN AVENUE • CHICAGO 14, ILLINOIS
Phone LAkeview 5-9116

LIST NO. 62 ON INFO-COUPON PAGE 143

USE OUR
HOEGANAES
SPONGE IRON POWDER
for
Powder Metallurgy Fabrication
and other
Metallurgical Purposes
EKSTRAND & THOLAND, Inc.
441 Lexington Avenue
New York 17, N. Y.

LIST NO. 63 ON INFO-COUPON PAGE 143

CONSERVE METALS
with 3 DIMENSIONAL
Rigidized Metals

You'll get:
- REDUCED WEIGHT
- ADDED STRENGTH
- IMPACT RESISTANCE
- SURFACE PROTECTION
- REDUCED MAINTENANCE COSTS
- MORE SQUARE FEET PER POUND OF METAL

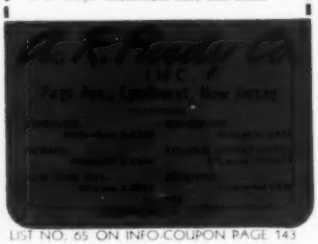
WRITE FOR FREE CONSERVATION HANDBOOK

Rigidized Metals Corporation
682 OHIO STREET, BUFFALO 3, N. Y.
Offices in Principal Cities in U.S.A. & Canada

LIST NO. 64 ON INFO-COUPON PAGE 143

For Stainless Steels, Spring Steels, Cold Finished Steels, Drill Rods, Cold Rolled Strip, Cold Rolled Sheets, Aluminum Sheets and Bars

Stainless Steel in strip, sheet, bars, tubing and accessories.
Cold Finished Steels in all standard shapes and carbon analyses.
Spring Steels in Blue Tempered and Polished Coils, Cold Rolled Annealed Coils and Straight Lengths in 1070 and 1095 Carbon grades and Hot Rolled SAE 1095 and 9255 Bars. Wires include Polished Music Spring Wire, Black Oil Tempered Spring Wire.
Cold Rolled Sheets — Cold Rolled Strip in coils and straight lengths, all tempers, slit, sheared and round edge.
Planet Drill Rods Rounds sizes from .013 to 2 in. – flats and squares.
Aluminum Sheets in coils and straight lengths in all alloys. – **Aluminum Bars and Rods.**



LIST NO. 65 ON INFO-COUPON PAGE 143

"SILVERCOTE"®
BERYLLIUM COPPER
Hardenable & Tempered
ALSO OTHER NON-FERROUS
WIRES
for
★ SPRINGS
★ FORMS
★ SPECIAL PURPOSES

LITTLE FALLS ALLOYS
INCORPORATED
189 Caldwell Ave. • Paterson 1, N. J.

LIST NO. 66 ON INFO-COUPON PAGE 143

WHITELIGHT
MAGNESIUM
your comprehensive independent source of magnesium alloy
Tubes ● Rods ● Shapes ● Bars
Hollow Extrusions ● Plate ● Strip
● Pipe ● Wire ● Welded and Riveted structures and assemblies

WHITELIGHT MAGNESIUM

WHITE METAL ROLLING & STAMPING CORP.
82 Moultrie St., Brooklyn 22, N. Y.
Sales Office
376 Lafayette St., New York 3, N. Y.

LIST NO. 67 ON INFO-COUPON PAGE 143

LEAKE
Creative
METAL STAMPINGS
Any Size-Shape-Thickness-Analysis
Literature on request
THE LEAKE STAMPING CO.
MONROE, MICHIGAN
LIST NO. 68 ON INFO-COUPON BELOW

WELDER'S CRAYON
KORN'S welder's crayon
Korn's special crayons, developed specifically for welding operators, layout men and other metal workers, will produce permanent markings on all types of hot, cold, wet or dry metals. Mark your cutting and welding lines for easier and more accurate results.
Wm. KORN, INC.
60 WEST ST. • DEPT. M.P.
NEW YORK 13, NEW YORK
LIST NO. 70 ON INFO-COUPON BELOW

WAGNER
ELECTRODE HOLDERS
WELD BETTER WITH
• WAGNER GROUND CLAMPS
• WAGNER CABLE CONNECTORS
• WAGNER "SWEDG-ON" ITEMS
Sold Only Thru Welding Supply Houses
WAGNER MFG. CO.
350 W. 1st SOUTH ST.
JACKSON, MISSOURI
Weld with Wagner
LIST NO. 69 ON INFO-COUPON BELOW

A CABLE SPLICED IN 10 SECONDS!

ERICO PRODUCTS, INC.
Complete Arc Welding Accessories
2070 E. 61st Place, Cleveland 3, Ohio
Write for Caddy Catalog
LIST NO. 71 ON INFO-COUPON BELOW

MAURATH, INC.
★ MANUFACTURERS AND PROCESSORS OF STAINLESS AND HEAT RESISTANT ARC WELDING ELECTRODES
★ ALL ANALYSES—COATED, STRAIGHTENED AND CUT, OR COILED FOR AUTOMATIC WELDING
MAURATH, INC.
21830 MILES AVENUE Telephone: MOntrose 2-6100 NORTH RANDALL (CLEVELAND 22), OHIO

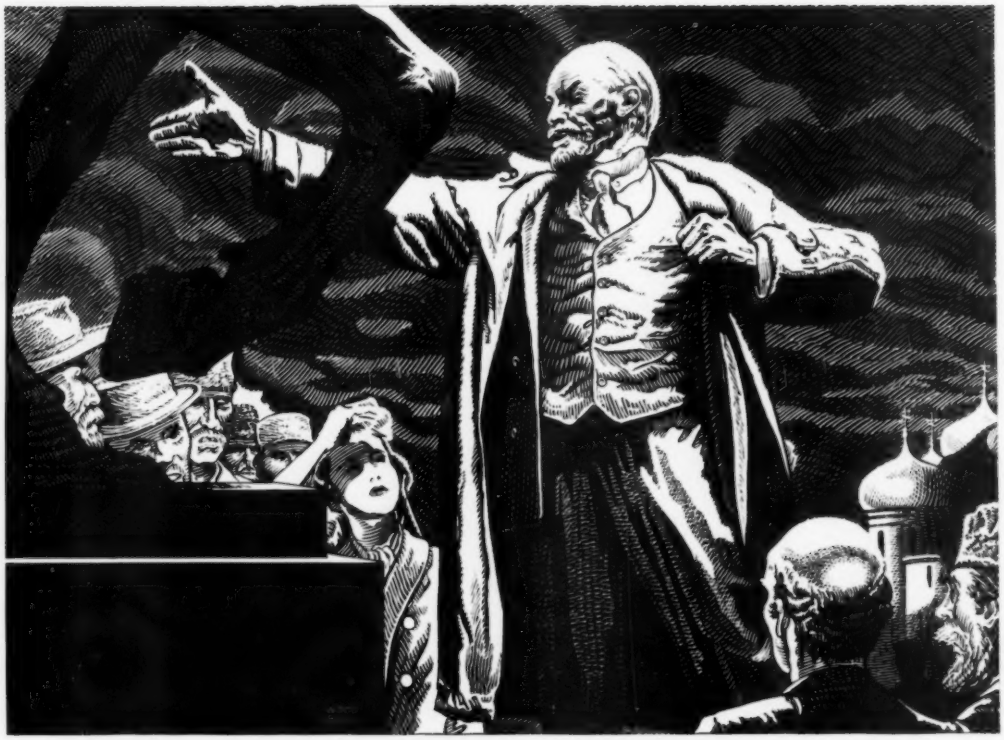
LIST NO. 72 ON INFO-COUPON AT LEFT

READERS' INFO-COUPON SERVICE, METAL PROGRESS
7301 Euclid Avenue, Cleveland 3, Ohio

Please send further information, as checked at the right, on the advertisements in the Bulletin Board with numbers I have listed below—

(Bulletin Board Item Number)	(Please check) Send Catalog or Engineering Data	Send Price Info	Nearest Source of Supply
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐

Your Name _____ Title _____
Company _____
Street _____
City _____ Zone _____ State _____



Let us prove this prophet false

"We shall force the United States to spend itself into destruction."

These are the words of Lenin, father of Russian Communism. Quoted from page 191, volume xxi, of his Collected Works, they were printed recently in a metropolitan newspaper.

This is the announced goal of the Politburo, and it is the direction in which many patriotic citizens fear we are headed. For example, Congress has just appropriated $87 billion to be spent during 1952, and enacted taxes estimated to produce only $71 billion. The deficit is to be added to our national debt, already $259 billion; and this deficit will depreciate the national currency by another $16 billion.

Part of this stupendous appropriation is to rearm ourselves and the free world against Communist attack. But what about the rest of our spending?... Let us also be realistic. It is time for us as a nation to pause, reflect and consider well. We can do three things to avoid national bankruptcy:

1. Eliminate every non-essential federal expense.
2. Provide taxes to pay all obligations as we go.
3. Pay off some of our national debt every year.

Let every citizen who believes in preserving our nation from the economic termites within, as well as from the announced enemy without, become an active worker to prove the Russian prophet false.

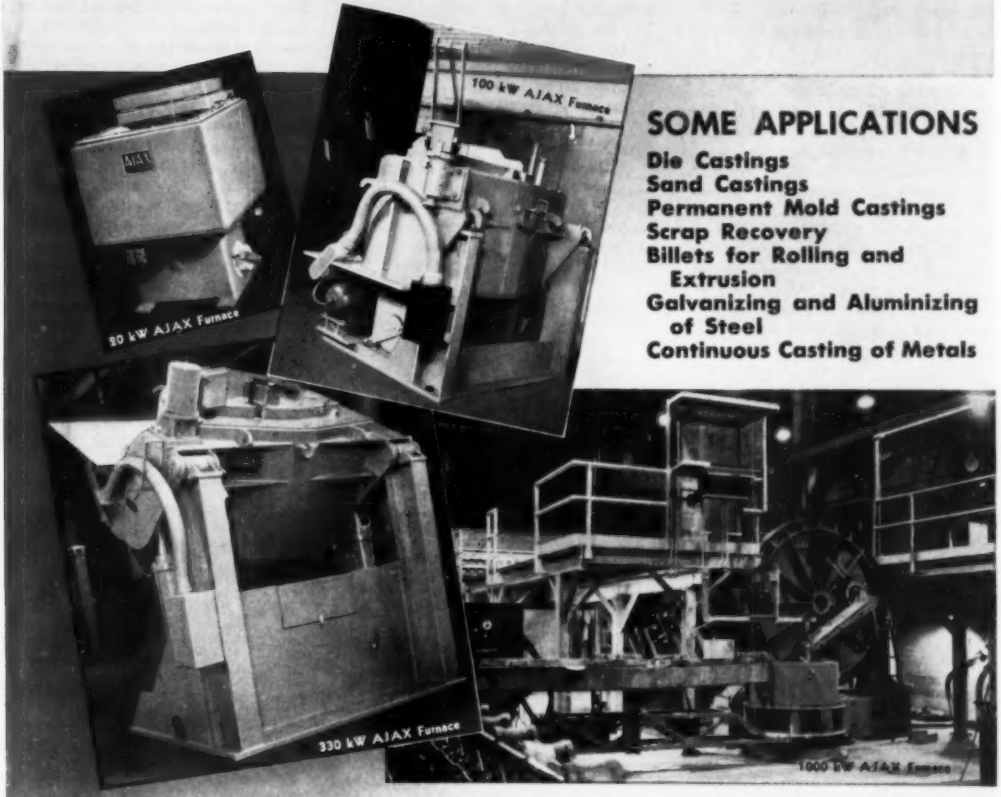
YOUR SCRAP YOUNGSTOWN IS NEEDED

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio
Export Offices--500 Fifth Avenue, New York
MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

Yes! AJAX Induction Melting Furnaces are Versatile!



SOME APPLICATIONS

Die Castings
Sand Castings
Permanent Mold Castings
Scrap Recovery
Billets for Rolling and Extrusion
Galvanizing and Aluminizing of Steel
Continuous Casting of Metals

AJAX-TAMA-WYATT Low Frequency Induction Furnaces are made in a wide range of sizes, from 20 to 1000 kW, to meet demand for large volume or small special lots. They are adapted to the full range of non-ferrous metals and alloys. Their use insures faster production, uniform quality, less maintenance and lower operating cost.

Rejects are reduced. For special applications, an Automatic Electromagnetic Pump allows continuous feeding of molten metal into the molds as they move past. Hand ladling is eliminated. Temperature is also automatically controlled and there is no chance of overheating the bath at any time during the melting cycle.

Write For Further Information

AJAX ENGINEERING CORP., TRENTON 7, N. J.

AJAX TAMA-WYATT = **INDUCTION MELTING FURNACE**

AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Wyatt Induction Furnaces for Melting

New Super-Alloys

(Continued from p. 127)

Where corrosion, erosion, abrasion, and temperatures up to 1000° F. are in combination (as in compressor blades, bolts and disks) ferritic stainless alloys have been favored.

The authors studied the resistance to stress corrosion of many lower alloy steels, and reached the following tentative conclusions:

In hardnesses between C-30 and C-40, A.M.S. 5615 (13 Cr, 2 Ni, 3 W, 0.4 Cr, 0.15 C) is the least susceptible ferritic stainless alloy, and under the conditions used, S.A.E. 4340 (1.8 Ni, 0.8 Cr, 0.2 Mo) and S.A.E. 8740 (0.5 Ni, 0.5 Cr, 0.2 Mo) were clearly superior to the stainless alloys, and therefore offer opportunities for conservation in the compressor end of the jet engine.

High-Temperature Sheet — Burner liners, ducts, and tail cones run at temperatures from 1200 to 1800° F. and must resist buckling failure from high thermal gradients. Hence low thermal expansion is an added requirement. So far these parts have been made of alloys of the Ni-Cr family (for example, A.M.S. 5540: 74 Ni, 15 Cr, 8 Fe). A promising substitute is a low-carbon alloy with 35 Ni, 20 Cr, 1 Ti, 42 Fe. [Abstractor's Note — Ceramic coatings will also help in the hot spots.]

Guide Vanes are subject to severe temperature gradients and should retain accurate shape to 1600°. Hollow, uniform-walled construction is desirable, but so far impracticable, so investment castings of cobalt-base alloys are always used, such as A.M.S. 5385 (62 Co, 27 Cr, 6 Mo, 3 Ni, 0.7 Mn). Its rupture time is 130 hr. at 20,000 psi. and 1500° F. Three promising substitutes replace much of the cobalt with much less scarce nickel. Typical composition is 30 Ni, 25 Cr, 20 Co, 6 W, 4 Mo, 1.5 Mn, 0.3 C, 0.2 N, and rupture time is 125 hr.

Turbine Disks cannot at present be cooled. Requirements are: Rims strong at 1200° F., hubs at least 75,000 psi. yield at 70° F., good ductility throughout to ease stress concentrations. Suitable austenitic

alloys must be forged at temperatures below recrystallization to acquire high yield, so disks above 18 in. diameter are usually composite, with austenitic rim welded to heat treated steel hub. Heat treatable alloys, precipitation hardening (2.6 Ni, 15 Cr, 3 Mo, 2 Ti, 0.2 Al, 52 Fe, 0.05 C) have been made commercially and "fully tested in engines with generally excellent results". They have properties which suggest use in bolts and turbine blades that operate at less than 1100° F.

Turbine Blades must carry high loads at 1500° F. and hotter. Satisfactory experience has resulted in general acceptance of A.M.S. 5765 forging alloy (45 Co, 20.5 Cr, 20.5 Ni, 4 Mo, 4 W, 4 Cb, 0.40 C) and A.M.S. 5382 investment casting alloy (55 Co, 25.5 Cr, 10.5 Ni, 7.5 W, 0.50 C). Extensive efforts to find a balanced composition much lower in cobalt have led to nickel-base, precipitation hardening alloys of which "Waspaloy" is a representative (59 Ni, 19.5 Cr, 13.5 Co, 3 Mo, 2.5 Ti, 1.2 Al, 0.07 C). Pratt & Whitney Aircraft "is currently developing this for turbine blades in advanced turbojet engines. Problems are many but do not appear incapable of solution". E. E. T.

OVER 5 TONS
NATIONAL FORGE & ORDNANCE COMPANY
Irvine, Warren Co., Penna.
STEEL MAKERS • FORGESMITHS • HEAT TREATERS • MACHINISTS • MACHINERY AND TESTING EQUIPMENT MFRS.

Direct Reduction of Iron Ore*

RESULTS of a three-year research of methods for the direct reduction of iron ore (sponsored by Inland Steel Co.) conducted at the Illinois Institute of Gas Technology are described. Since the reduction of iron ore is a gas-solid reaction, the techniques of "gasifying" the solid component in a stream of reducing gas seemed to offer the best means of effecting the complete reduction of iron ores to metallic iron powder. The repeated failures over several hundred years of other methods for the direct reduction of iron ore to metal without complete fusion of the reduced metal are well known. The main difficulty has always been the impossibility of producing metal that did not contain over 1% impurities and did not have pyrophoric properties which cause the reduced iron powder to revert to iron oxide on exposure to air at even normal temperatures.

This research involved the grinding of seven iron-bearing materials to a very fine state, suspending the minerals in a reducing gas of sufficient velocity to keep the solids fluidized, heating the gas-solid mixture to different reduction temperatures, holding the reaction condition constant for varying times and then analyzing the solid product to determine the extent of reduction obtained and the purity of the iron powder produced. The chemical analyses of the materials that were studied for their ease of reduction are given in the accompanying tabulation.

*Abstract of "Direct Reduction of Iron Ore Using the Fluidized Solids Technique", by M. Tenenbaum and C. M. Squarcy, American Iron & Steel Institute Yearbook, 1951, p. 208-240.

The mill scale was obtained during the hot rolling of steel; a New York magnetite was specially treated to provide the high grade concentrate. This material had the finest screen size of those studied; the flue dust had the coarsest particles. The taconite was coarser grained than that normally encountered on the Mesabi range.

All of the materials were in a very fine state ranging from 30% to over 90% through a 325-mesh screen and almost 100% through 170-mesh. This control was necessary, since particle size distribution is an important

Material	Fe_2O_3	Fe_3O_4	Fe	Al_2O_3	SiO_2	C
	Chemical Analysis, Per Cent					
Magnetic Core	—	98.31	71.14	—	0.44	—
Coarse Taconite	13.72	31.23	32.20	1.38	44.76	—
Mill Scale	—	98.53	70.50	—	0.51	—
Mesabi Ore	81.36	—	56.90	—	8.40	—
Blast Furnace Dust (Dry)	38.46	38.55	54.80	2.76	10.31	4.72
Blast Furnace Dust (Wet)	69.80	—	56.30	—	14.40	5.6
Waste Tailings	23.31	—	16.30	—	75.00	—

factor in obtaining effective fluidization and intimate gas-solid contact in the reaction vessel.

Preliminary static tests were made on each type of oxide to determine the effect of temperature on the rate of reduction. This work was done by passing hydrogen gas over samples containing 3.22 grams of iron at temperatures varying between 850 and 1850° F.; the duration of testing ranged between 5 and 100 min. at each temperature.

The tests indicated that the optimum reduction temperature for the samples containing Fe_2O_3 was 1100° F. and that higher temperatures gave a lower amount of reduction. This tendency was much less pronounced for the mill scale (magnetic oxide) than *(To p. 148)*

in research...or production control

costs
when analysis are important

SPECTROSCOPY IS ESSENTIAL

Latest in the large and growing line of **Jaco** Spectrochemical Instruments. The 3.4 Meter Stigmatic Grating Spectrograph and Varisource Excitation Unit for high alloy steel, mineral, and high temperature alloy analysis.

COSTS

— are they getting out of hand in your analyses for research or production control? Time then that you discover the significant economies effected through the use of **Jaco** spectrochemical equipment. Tests have shown that complete determinations (seven elements) in aluminum, for example, **total as much as six dollars less per sample by spectrochemical analysis than by wet chemical methods.** Steel analyses show comparable savings. What's more, when you use a spectrograph, the addition of determinations in any given alloy has only negligible effect on costs.

What can spectrographic analysis mean in dollars and cents to you? **Jaco** technologists are anxious to show you — write for their help today.

jaco

JARRELL-ASH COMPANY
165 NEWBURY STREET
BOSTON 16, MASS.

BRANCH OFFICES: DETROIT · EL CERRITO, CALIF. · CHATTANOOGA

FINE SPECTROCHEMICAL INSTRUMENTS for SCIENCE and INDUSTRY

Direct Reduction of Iron Ore

(Continued from p. 147)

for magnetic core and coarse taconite (containing natural magnetite). The hematitic specimens (Mesabi ore, blast furnace dust and waste tailings) reduced readily at all temperatures, the rate of reduction increasing with temperatures.

The samples from the reducibility tests were cooled in the reducing gas before analysis. The extent of reduction varied from 10% for 5 min. at 850° F. to as high as 95% for 100 min. at higher temperatures. In no test was complete reduction recorded. When the reduced material was cooled for 30 min. in nitrogen, a considerable degree of reoxidation occurred, the amount being higher for higher reduction temperatures. This result was especially noticeable in the magnetite samples, the coarse taconite showing reoxidation as much as 20% for reduction temperatures between 1300 and 1600° F. The reoxidation of the hematitic materials ranged from 5 to 10% between 1200 and 1600° F. reduction temperature. These results, obtained under carefully controlled laboratory conditions, emphasize the great difficulty of handling large quantities of reduced iron powder in an industrial plant without the occurrence of a considerable reversion of the metal powder back to the oxide state. This reoxidation becomes very rapid whenever the reduced powder is reheated in a furnace for melting and is one of the main factors in the failure of recent industrial attempts to produce sponge iron for steel making.

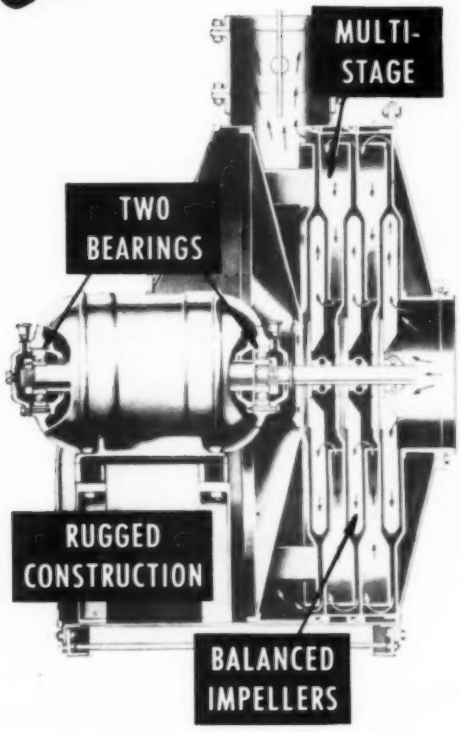
Following the static tests each of the seven materials was subjected to reduction using the fluidized solids technique in a specially designed apparatus. In each instance the most favorable reduction temperature and reaction time was used to obtain the maximum degree of reduction indicated for each material in the static tests. The equipment consisted of a preheater for heating the hydrogen gas to the required temperature, pressure regulators to maintain sufficient gas velocity to keep the fine solids fluidized in the reactor column, heating coils to keep the reactor column at the reduction temperature, dust collectors and water condensers in the effluent gas stream. Over 40 tests were made and the best results obtained are summarized as follows:

(Continued on p. 150)

CONTINUOUS PRODUCTION

Assured 4 Ways

WITH SPENCER TURBO-COMPRESSORS



There are good reasons why the annual installation of Spencer Turbos has increased tenfold in ten years and why a recent analysis shows that repair parts amount to less than one dollar per machine per year.

No. 1. The Spencer multi-stage construction allows a smaller diameter machine with lower peripheral speeds of the fan blades and of the motor itself. The wear on the bearings is therefore cut to a minimum.

No. 2. The only rotating contacts are at the two ball bearings, which if kept greased will assure satisfactory operation without work stoppages for many years.

No. 3. Here is a machine as simple as an electric fan, with a rugged construction, as sturdy as a steel bridge and with wide clearances between the rotating elements and stationary parts. Users say "the Spencer goes on forever with little attention."

No. 4. Balanced Impellers. Each fan is individually balanced before the machine is assembled. This decreases the vibration, increases the life of the bearings and packing and produces quiet performance.

35 TO 20,000 C.F.M.; 4 OZ. TO 10 LBS.; 1/3 TO 1,000 H.P. 440-H

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

SPENCER
HARTFORD

ASK BARRETT

for information on

DISSOCIATED ANHYDROUS AMMONIA

for metal treating

You effect real economies in metal treating when you use Barrett* Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen.

When dissociated, one 150-pound cylinder of Barrett Standard Anhydrous Ammonia (Refrigeration Grade) yields 6,750 cubic feet of mixed gases—approximately 5,100 cubic feet of hydrogen and 1,650 cubic feet of nitrogen.

Engineers have obtained many advantages from the use of dissociated ammonia as controlled atmosphere in furnaces for bright annealing, carbonitriding, clean hardening, copper brazing, sintering of metal powder compacts, reduction of metallic oxides, atomic hydrogen welding, and radio tube firing and sealing. Anhydrous ammonia also has unsurpassed qualities in the nitriding of steel, used as ammonia gas or dissociated.

The advice and assistance of Barrett technical men are readily available. For information, contact Barrett, *America's leading distributor of ammonia.*

Barrett Standard Anhydrous Ammonia

In 150, 100 and 50-pound cylinders for fast delivery from a stock point located near you. And in tank car shipments from Hopewell, Va., and South Point, Ohio.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.

America's Leading Distributor of AMMONIA

Barrett*

*Reg. U. S. Pat. Off.

Direct Reduction of Iron Ore

(Continued from p. 148)

Material	Highest Reduction
Magnetic Concentrate	64.8%
Coarse Taconite	91.0
Mill Scale	81.8
Blast Furnace Flue Dust	95.3
Hematite Iron Ore	89.0
Wash Ore Tailings	87.5

It is obvious that the treated materials contained considerable amounts of iron oxides and gangue material even after the most careful procedure. The table of analyses does not show the amount of silica still present in the reduced powder, but only indicates the extent of the reduction of the iron oxide. Actually, the reduced powders contained 3.3 to 45% SiO_2 and the metallic iron content varied from 44.5 to 72.8%.

The authors conclude that the product obtained in these experiments is merely a beneficiated iron ore and that it is in no way suitable as an iron charge in the open hearth or for powder metallurgy applications. They state, "It seems difficult to conceive of a situation wherein the expense of direct reduction by fluidization technique or any other sponge iron scheme can be justified for the production of a blast furnace charge material. (This conclusion does not necessarily apply to magnetic roasting for simple iron ore concentration.) It should be brought out that neither in theory nor in practice can direct reduction schemes be considered as methods for independent steel production."

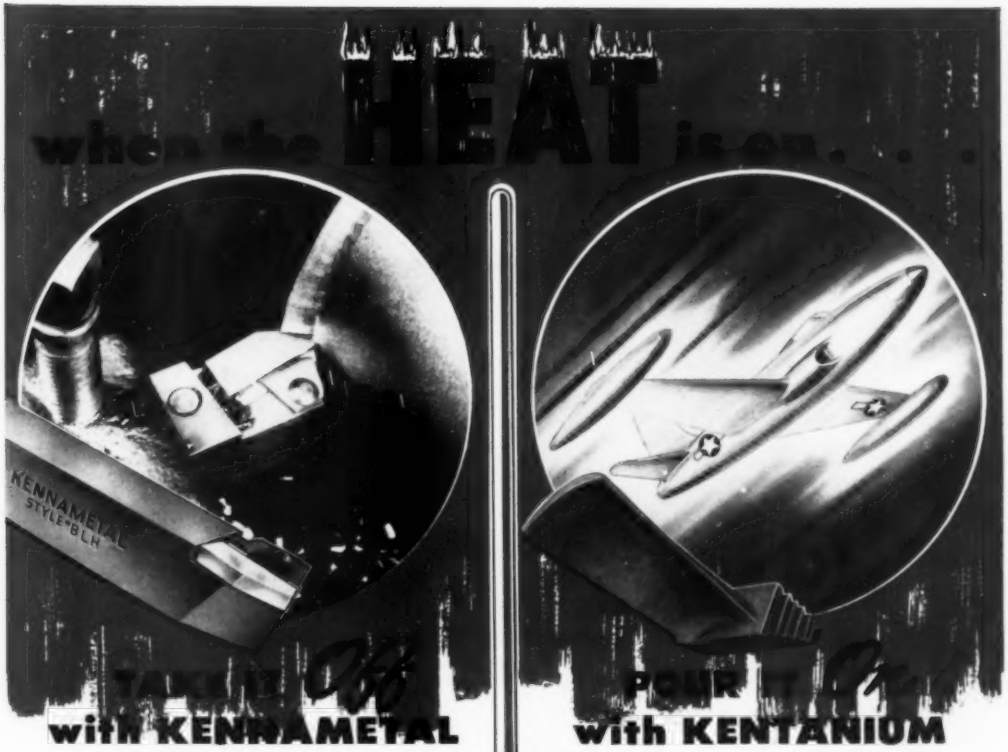
E. C. Wright

Stains on Aluminum-Sprayed Steel Surfaces*

Appearance of brown rust stains on structural steel sprayed with aluminum by means of a gun and metallic wire, often within a few hours after application, do not indicate a premature breakdown of the coating and have no significance in determining the life of the protective aluminum layer. Stains are more likely on thin coatings, yet deposits of 0.002 in. do not always stain and, conversely, a layer of 0.005 in. may show discoloration under certain conditions.

(Continued on p. 154)

*Abstract of "The Protection of Steel by Sprayed Aluminum", by W. E. Ballard, *Electroplating and Metal Spraying*, Vol. 4, December 1951, p. 395-399.



with KENNAMETAL

When the metal-cutting job is rugged — specifications precise — delivery schedule tight — use Kennametal tooling to "take off the heat".

Kennametal tools are remarkably hard, strong, and tough. They stay on the job longer . . . require fewer trips to the grinding room. Idle machine time is minimized . . . skilled operators work to best advantage . . . tooling costs drop—and productivity rises through higher speed and heavier feeds.

Kennametal gives this superior performance — consistently — because its physical structure is sound and uniform — a characteristic which is imparted and maintained by distinctive processes under the direction of men who know carbides from "the ground floor, on up".*

Men — with technical "know-how" — make Kennametal an outstanding tool material. And — the skilled men who operate and are in charge of metal-cutting machines fully realize its plus-value when "the heat is on".

with KENTANIUM

When there is urgent need for a material having longer service life and improved performance under high temperatures — Kentanium offers outstanding advantages.

It has much better stress rupture characteristics than conventional alloys even at 1600° F, a superiority that becomes more pronounced as temperatures increase. From 1800° F to 2200° F, for long periods, and up to 4500° F for short exposures, it withstands oxidation while retaining unusually high strength, and shows no weakening under thermal shock.

Much lighter than steels and conventional alloys, it presents design and operating advantages, particularly for rotating, or reciprocating parts.

Kentanium is suitable for: gas turbine components, valves and seats for gas engines, hot spinning tools, hot extrusion dies, and many other applications. If your design problem involves high temperature conditions, let us demonstrate how you can safely "pour on" more heat when structural elements are made of Kentanium.*

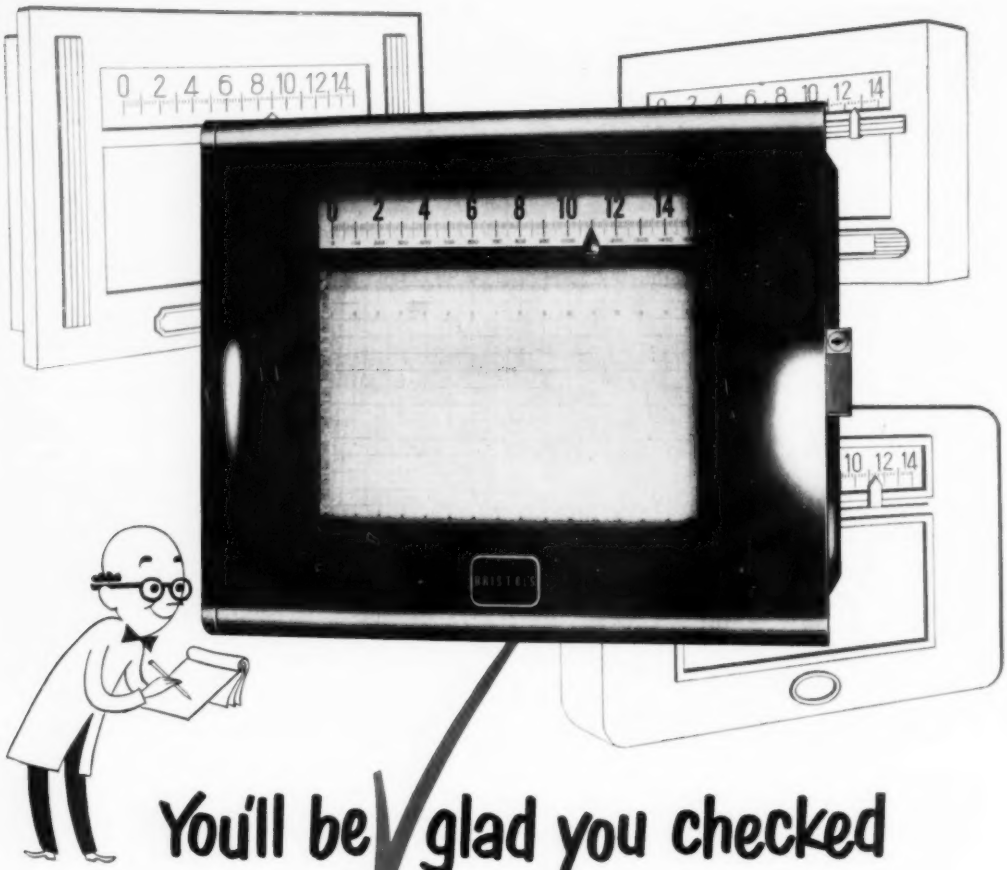
KENNAMETAL

*Kennametal Inc. mines basic raw materials, refines all its carbides directly from ores, oxides, and by-products, processes these carbides into Kennametal compositions . . . then engineers and fabricates complete tools and wear-part designs that fully utilize the distinctive properties of Kennametal.

KENNAMETAL®
SUPERIOR CEMENTED CARBIDES
KENNAMETAL Inc. LATROBE, PA.

KENTANIUM

*Kentanium—developed and produced exclusively by Kennametal Inc.—is chiefly titanium carbide with nickel as auxiliary metal (no tungsten or cobalt). Made in several different compositions to meet varying conditions. Available as standard extruded shapes . . simple molded forms . . intricate designs.



You'll be glad you checked BRISTOL'S DYNAMASTER

Electronic temperature recorders and controllers

A high-speed, accurate electronic brain to measure, record, and control d-c voltage, d-c current, resistance, capacitance—or any variable that can be converted into those quantities.

The continuous-balancing circuit responds to minute changes *instantly*.

Available as a self-balancing bridge or potentiometer, the Dynamaster is a versatile, dependable, trouble-free measuring instrument.

BRISTOL

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

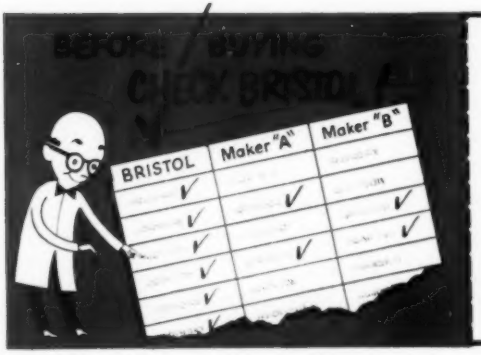
CHECK THESE ✓ practical features

- Simple design for long, trouble-free operation
- Little or no maintenance
- Electronic component uses vacuum tubes available from any radio supply house
- Full-scale pen travel in 7, 3, or ⅔ seconds
- Chart speeds from ¾ in. per hour to 7200 in. per hour
- Multipoint recorders up to 16 points
- Same amplifier used on all Dynamaster models . . . can be removed and replaced with nothing but a screwdriver
- Periodic automatic standardization on potentiometer models
- Exceptionally unaffected by stray currents (1000 to 1 discrimination)
- Practically immune to vibration or shock

FOR MORE INFORMATION *on how Dynamaster can solve your measurement problems, use the coupon to send for Catalog No. P1245.*

COMPANIES LIKE THESE *are using Dynamasters*

North American Cyanamid Limited
Jones & Laughlin Steel Corporation
Raybestos-Manhattan, Inc.
Manhattan Rubber Division
Consolidated Edison Co. of New York, Inc.
Friez Instrument Division,
Bendix Aviation Corp.
Scovill Manufacturing Company
Pratt & Whitney Division,
Niles-Bement-Pond Co.
International Harvester Company
Westinghouse Electric Corporation
The Johns Hopkins University
United Aircraft Corporation
The Sponge Rubber Products Company
Commercial Solvents Corporation
Armstrong Cork Company
United States Steel Company
Collins Radio Company
Baldwin-Lima-Hamilton Corp.
Ruge-de Forrest Company
National Bureau of Standards
Bausch & Lomb Optical Company
Koppers Company, Inc.
Bell Aircraft Corporation
The B. F. Goodrich Company
Boeing Airplane Company
Industrial Nucleonics Corp.
E. I. du Pont de Nemours & Co., Inc.
Automatic Temperature Control Co., Inc.
Swindell-Dressler Corporation
Woods Hole Oceanographic Institution
Jarrell-Ash Company
National Research Corporation



THE BRISTOL COMPANY
106 Bristol Road
Waterbury 20, Conn.

Please send catalog giving details of Dynamaster performance to:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

YOUR HARDNESS TESTER...

IS ONLY AS GOOD AS THE DIAMOND IT USES

Standard "C" Diamond Cone

Dependably accurate "Rockwell" testing results are obtained only when every part of your hardness testing equipment is made to precision limits. That is why a correctly designed diamond penetrator is of such great importance. Always specify CLARK Diamond Cone Penetrators, both for Standard and for Superficial "Rockwell" testing. They are accurately made to the proper size and shape; exactly formed by expert lappers. CLARK Penetrators are designed for use on all "Rockwell" type testing machines.

CLARK

TOMORROW'S ACCURACY TODAY

INSTRUMENT, INC.

10900 FORD ROAD
DEARBORN, MICH.

Stains on Aluminum-Sprayed Steel Surfaces

(Continued from p. 150)

Staining, which can be removed by wire brushing, appears most rapidly if water is permitted to stand on the coating, thus making it most prevalent in the "V" of angles or in channels of joists. If the coated surfaces can be exposed to dry weather for 30 days, the spotting is not likely to occur. Treatment with water containing small amounts of sulphuric acid or aluminum salts also suppresses the action.

Tests show that the deposit of aluminum becomes almost neutral in its electrochemical behavior, with staining related to chemical actions developing in pores in the coating, varying considerably in size and reaching down to the steel base. They permit entrance of liquids and air (oxygen), setting up galvanic cells. Formation of ferrous salts may block some pores or may result in seepage from others, thereby resulting in stains.

Some disconnected pores may become cells having an excess of ferrous ions at the bottom and excess of hydroxyl ions at the top, due to poor oxygen intake. In this event, the aluminum will become cathodic to the steel and the base metal will be attacked more rapidly at the bottom of the pore. This results in more ferrous salts being formed on the steel and more alkali on the aluminum. Alkaline liquor descending into the pores precipitates ferrous hydroxide which tends to stifle further action, oxygen being completely excluded from the steel. On drying, the "bridge" oxidizes to seal the pore.

With the acid electrolyte, such as water containing sulphur products from the atmosphere, aluminum tends to be anodic, protecting the steel by sacrificial action. White aluminum salts form at the top of the pores to seal them, although on drying, aluminum hydroxide shrinks more than the iron hydroxide underneath, since it contains more water; this causes a slowdown in the sacrificial action and pore stifling.

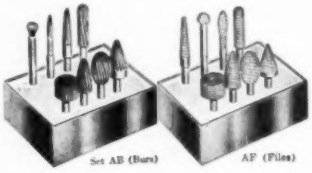
Long-term exposure of aluminum-coated steel to the atmosphere may be marked by a change in the coating to a hard and powdery condition, with gradual washing away by rain. Indications are that the destruction of the deposit is due to its slow corrosion by attack through the protecting oxide film. It is un-

(Continued on p. 156)

MARTINDALE

ROTARY BURS AND FILES

Made of high-speed steel. Produced in our own factory where uniform hardness is assured by heat-treating in electric furnaces on which the temperature is closely controlled by electric eyes.



Set AB (Burs) AF (Files)

Sets AB & AF	Per Set
1 set	$11 05 net
2 to 11 sets	9 75 net
12 or more	8 45 net

The above sets, with ¼" diameter shanks, are composed of the 8 most popular sizes for general use.

Over 200 sizes and shapes (total over 75,000 pieces) are carried in stock for immediate shipment.

METAL-WORKING SAWS

Made of 18-4-1 High Speed Steel in 4 types for ferrous and nonferrous metals. Diameters range from 1¾" to 4".

"MOTOR-FLEX" GRINDERS

These high-quality, portable flexible-shaft tools are made in 7 types for operation on bench, floor, or overhead.

Write for 64-page Catalog No. 28 covering above and many other products for maintenance, safety, and production.

MARTINDALE ELECTRIC CO.

1372 Hird Avenue, Cleveland 7, Ohio

Supply and demand in a photo-finish?

Actual photograph of photo-finish at a leading race track

What's the steel picture today?

Our comparison isn't too far-fetched.

The steel picture today is a race between supply and demand. For months, demand has been away out front. There hasn't been enough steel to go around. Military requirements and government allocations have had to come first.

But it won't always be that way.

And against the day when supply and demand reach a better balance, we want you to remember this:

Wisconsin Steel is known for quality.

Wisconsin Steel is known for keeping its promises, on specifications and on delivery dates.

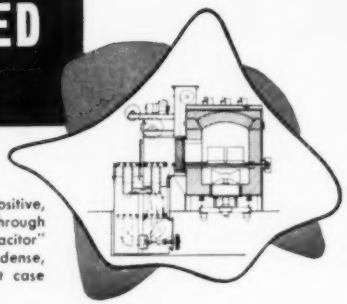
We hope you'll have these facts in mind when we are able to ask you for an order.

INTERNATIONAL HARVESTER

WISCONSIN STEEL COMPANY, affiliate of INTERNATIONAL HARVESTER COMPANY
180 North Michigan Avenue, Chicago 1, Illinois

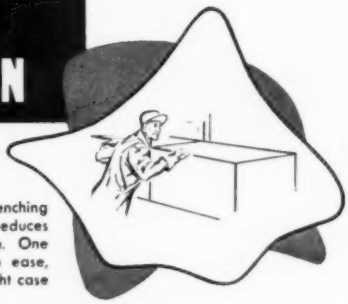
WISCONSIN STEEL

UNSURPASSED QUALITY



Combines the operating economies of large continuous furnaces with the flexibility of batch-type equipment. Positive, directed flow of furnace atmosphere through load, combined with the "heat capacitor" assures rapid, uniform heating on dense, bulk-loaded parts and even on light case work.

GREATER PRODUCTION



The Dow Furnace has established production records in plants throughout the country. Forced, uniform quenching from atmosphere gives full hardness, reduces distortion, eliminates decarburization. One man can operate two furnaces with ease, producing as much as 1500-lbs. of light case work per hour.

WIDER VERSATILITY

Whether it's gas cyaniding, gas carburizing, clean hardening or carbon restoration work, the Dow Furnace is capable of processing a variety of parts having a wide range of heat treatments. To demonstrate the close tolerances of heat treatments, send us samples of your own parts for processing.

AT LOWER COSTS

Reductions in direct labor, material handling, machining and cleaning costs, coupled with improved quality, have resulted in savings amortizing the original cost of the Dow Furnace in a few months. Gas cyanides for ¼ to ⅓ the cost of liquid cyaniding.

THE DOW FURNACE COMPANY

FIRST WITH MECHANIZED BATCH-TYPE CONTROLLED ATMOSPHERE FURNACES

12045 Woodbine Ave. • Detroit 28, Michigan
KEnwood 2-9100

Stains on Aluminum-Sprayed Steel Surfaces

(Continued from p. 154)

usual for an aluminum coating to fail by blistering or breaking away, except in very acid conditions.

Where aluminum is strongly anodic to the base metal and hydrogen is being liberated at the steel surface, small blisters sometimes appear which either gradually disappear or become hard and inactive. This is due to the build-up and bridging of corrosion products.

Prevention of aluminum staining might be approached from: *(a)* Improved spraying technique to reduce porosity; *(b)* increasing the coating thickness to, say, 0.004 in.; *(c)* use of an aluminum alloy containing 10% zinc (not recommended because of the weakening effect on the aluminum oxide film); *(d)* applying a light film of paint or lacquer after spraying; and *(e)* spraying the fresh deposit with weak sulphuric acid or weak solutions of aluminum salts. In most of these, cost is a governing factor.

The practice of using a thin undercoating of zinc before spraying with aluminum is not recommended. Although it avoids any likelihood to rust staining because the corrosion products of aluminum and zinc are white, it also increases the danger of failure by blistering, particularly where immersion is involved, since pockets of hydrogen form under bridges of the metallic hydroxides.

Appearance of brown stains on freshly painted aluminum surfaces is most unwelcome. However, understanding of the mechanism behind their formation shows them for what they are and should dispel fears over the soundness of the coating. They seldom amount to over 5% of an entire surface, at their worst, and a light brushing followed by repainting eradicates them entirely.

A. H. Allen

Creep Properties of Austenitic Alloys*

In studying the influence of chemical composition on the high-temperature strength properties of a given system it is possible to keep the heat treating conditions constant

(Continued on p. 158)

*Abstract of "Creep Properties of Austenitic Alloys in Relation to the Constitution Diagram", by A. M. Borzdyka, *Doklady Akademii Nauk SSSR*, Vol. 75, 1950, p. 37-38.

VERSATILE
variety of control

SIMPLE
interchangeable assemblies

ACCURATE
¼ of 1% of full scale

ECONOMICAL
low original cost

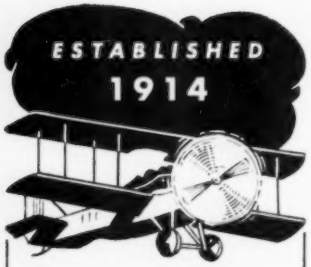
capacilog strip chart recorder

Capacilog Strip Chart Recorders operate with the Wheelco "Electronic Link" to provide a permanent record of temperature or other variables in industrial processing. All standard control combinations including pneumatic and electrical proportioning types are available.

For complete information on custom recording at "mass production" prices, ask for CAPACILOG BULLETIN C2. Wheelco Instruments Company, 835 West Harrison Street, Chicago 7, Illinois.

wheelco electronic control

Manufacturers of Capacitrol electronic controllers, Pyrotrol tools and accessories



NATIONALLY ACCEPTED

TESTING MACHINES

BRINELL
DUCTILITY
COMPRESSION
TENSILE
UNIVERSAL
TRANSVERSE
HYDROSTATIC
PROVING INSTRUMENTS

and Special Testing Machines built to your specifications.

Send for this Brochure

Steel City Testing Machines Inc.

8835 Livernois • Detroit 4, Mich.

Without obligation send me your brochure on testing instruments. Also special folders on following types (check your interest):

☐ Brinell Hardness ☐ Ductility
☐ Compression ☐ Tensile
☐ Transverse ☐ Hydrostatic
☐ Proving Instruments

NAME _____

TITLE _____

Attach coupon to your letterhead and mail

Creep Properties of Austenitic Alloys

(Continued from p. 156)

or to keep the structure constant. A formally similar heat treating schedule, such as quenching from 1000° C. (1830° F.), can produce dissimilar effects on the structure of the alloy because of differences in grain-growth tendencies and in solubilities of carbon in austenite. Such dissimilarities may mask the effect of composition variation on creep strength.

It is preferable to test alloys of a chosen system in the same structural condition with respect to grain size and the presence of a second (carbide) phase. In this connection, a preliminary study was previously made of the influence of composition on the structural transformations in highly alloyed austenite at high temperatures.

All of the alloys used in the experiments were tested to determine the stress corresponding to a creep rate of 10^{-6} mm. per mm. per hr. Such "creep limits" were determined at 600° C. (1110° F.) for the 12 binary and 34 ternary alloys indicated by circles in the iron-chromium-nickel diagram of Fig. 1. Compositions that showed about the same creep limit are connected by a line, and the corresponding stress in kg. per sq.mm. (1 kg. per sq.mm. = 1400 psi.) is indicated.

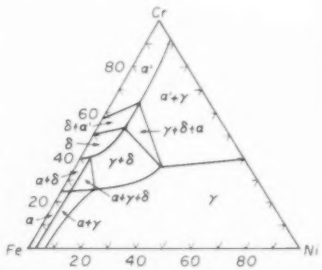


Fig. 1 — An Isothermal Section of the Iron-Chromium-Nickel Diagram Showing the Compositions and Creep Limits of Alloys Tested. Numbers near the composition circles are the stresses in 1400 psi. that produced a creep rate of 10^{-6} per hr. at 1110° F.

Of the eight "isocreep lines" shown in Fig. 1, five lie parallel to the iron-nickel side of the diagram and correspond to sections at 0, 10, 15, 20, and about 30% chromium. One isocreep line is parallel to the iron-chromium side of the diagram and is in the alpha-plus-gamma re-

(Continued on p. 162)

Tempilstiks®

the amazing Crayons that tell temperatures

A simple method of controlling temperatures in:

- **WELDING**
- **FLAME-CUTTING**
- **TEMPERING**
- **FORGING**
- **CASTING**
- **MOLDING**
- **DRAWING**
- **STRAIGHTENING**
- **HEAT-TREATING IN GENERAL**

Also available in pellet and liquid form

It's this simple: Select the Tempilstik® for the working temperature you want. Mark your workpiece with it. When the Tempilstik® mark melts, the specified temperature has been reached.

$2 each — gives up to 2000 readings

Available in these temperatures (°F)

113	263	400	950	1500
125	275	450	1000	1550
138	288	500	1050	1600
150	300	550	1100	1650
163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
238	388	900	1450	2000

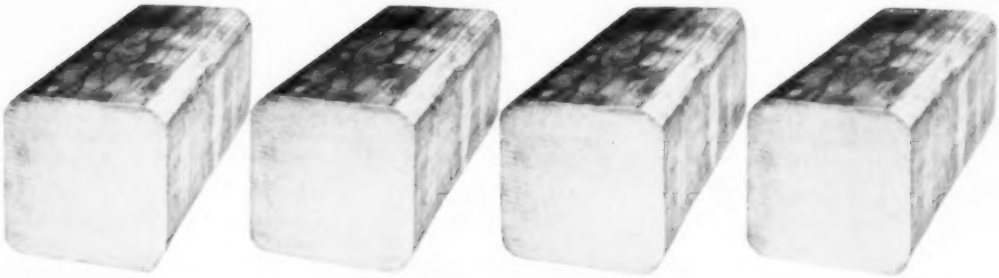
FREE —Tempil® "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

GORDON SERVICE

CLAUD S. GORDON CO.
Manufacturers & Distributors
Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines
Dept. 15 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 15 • 2035 Hamilton Ave., Cleveland 14, Ohio

To get uniform forgings here...

start with uniform TIMKEN® forging steels!



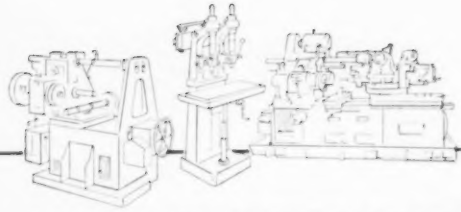
YOU can get uniform, high quality forgings and cut production costs too if you start by using uniform, high quality Timken® forging steels. With Timken forging steels, you're assured of uniform forgeability, uniform response to heat treatment, uniform machinability—from bar to bar and heat to heat. As a result, you have fewer rejects, fewer delays, fewer changes in shop practice.

The uniformity of Timken forging steels is the result of rigid quality control from melt shop through final inspection. For example, the Timken Company uses the direct reading spectrometer—first in the industry—to make possible instantaneous control and checking of every heat before it's tapped.

To learn how you can improve the quality of your forgings, cut production costs or both—get an "on-the-job" analysis by our Technical Staff. And for our bulletin No. 31, "Chemical Composition of Alloy Steels", write on your company letterhead to The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



YOU DON'T ALWAYS NEED MACHINE TOOLS FOR FINISHED MACHINE PARTS

Specify **OILITE**

PRODUCTS OF SINTERED METALS

With OILITE YOU:

- Eliminate Machine Tools
- Eliminate Tooling Progress
- Conserve Skilled Man Hours
- Conserve Strategic Material
- Get Quick Delivery

Other OILITE Advantages Include:

- Over 20 Years Production Experience
- An Alternate Material
- Engineered Products
- No Machining
- Low Price
- Release Skilled Man Power For Other Jobs

Field Engineers and Depots throughout U. S. and Canada

SINTERED OILITE PRODUCTS

AMPLEX MANUFACTURING COMPANY

Subsidiary of Chrysler Corporation

Detroit 31, Michigan

Oilite Products include: BEARINGS, Finished Machine Parts, Cored and Solid Bars, Permanent Filters, and Special Units.

Put

SuVeneer®

CLAD METAL

to work for you

on these and other strategic applications

- AUTOMOTIVE MOULDINGS
- INTERNAL COMBUSTION ENGINE HEAD GASKETS
- FLEXIBLE TUBING
- WIRE AND SWITCHBOARD TERMINALS
- HEAD GLEAM
- BULLET JACKETS
- SHELLS
- ELECTRIC WATER HEATER ELEMENT GASKETS (ETC.)

These uses of copper-and-steel SuVeneer Clad Metal typify the many ways in which critical copper is being conserved by alert manufacturers—*while maintaining full product performance.* ● SuVeneer Clad Metal lends itself admirably to fabrication by usual methods, is dimensionally accurate and uniform in behavior, and is furnished in easy-handling coils. *Write for complete details.*

Superior Steel

CORPORATION

CARNEGIE, PENNSYLVANIA

THE WIRE
WITH THE **Perfect Temper**

Many a production man thinks Chase engineers are "angels" for producing wire that unwinds from the coil smoothly and without twist. It's uniform in gauge, temper and color; has superior heading or flowing characteristics.

There's a Chase wire for most applications. Write for *FREE* booklet—"Chase Cold Heading Extruded Brass and Copper Alloy Wire" giving physical and fabrication properties, applications, weights per 1000 feet and feet per lb.

CMP orders. We can make favorable mill deliveries on authorized Controlled Materials orders. In many cases our warehouses can ship from stock. Your inquiries are invited.

● **CHASE TECHNICAL SERVICE**
Our metallurgical engineers are familiar with military specifications for brass and copper for ordnance components, and will be glad to consult with you on the selection of these metals for defense orders.

Chase **BRASS & COPPER**

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
Baltimore	Denver†	Milwaukee	Pittsburgh	Waterbury
Boston	Detroit	Minneapolis	Providence	
Chicago	Houston†	Newark	Rochester†	† Sales office only
Cincinnati	Indianapolis	New Orleans	St. Louis	

Manufacturers

LOOK FOR THIS SIGN

on the profit road . . .

•

Your profit for tomorrow will be decided by the work you produce today.

Keep every production line running with fewer breakdowns and less replacements by using ACCOLOY Heat and Corrosion Resistant castings.

The improved designs, finer grain size, the close control of pouring and the multiple testing of each finished piece, all contribute to the longer service life of these castings.

As a manufacturer using trays and fixtures, carburizing boxes, salt pots, retorts, muffles or roller rails — *make an investment now that will keep you posted on the profit side of the ledger.*

•

HEAT RESISTANT CASTINGS
ACCOLOY
STAINLESS STEEL CASTINGS

ALLOY ENGINEERING & CASTING COMPANY

ALLOY CASTING CO. (Div.)

CHAMPAIGN • ILLINOIS

ENGINEERS AND PRODUCERS OF HEAT AND CORROSION RESISTANT CASTINGS

Have you heard about

THE LUBRICANT OF MANY USES

Moly-sulfide

A LITTLE DOES A LOT

In the shop—

In the field

Moly-sulfide is a newly-introduced solid-film lubricant, highly successful in applications involving extreme pressures, high velocity, fretting, elevated temperatures and other difficult frictional conditions. We have compiled detailed records of 154 different applications of molybdenum sulfide to actual shop and field problems—some of which might be similar to your own.

Shopmen, engineers, lubrication specialists—write now for a copy of this new 40-page booklet.

Climax Molybdenum Company

500 Fifth Avenue
New York City

Please send me your Free Booklet

Name.....

Position.....

Company.....

Address.....

MP3 MS4

Creep Properties of Austenitic Alloys

(Continued from p. 158)

gion. Two lines, which are essentially extensions of each other, correspond to binary iron-chromium alloys.

It is evident that nickel austenite has lower creep strength than chromium-nickel austenite. Also, alloys that lie just beyond the austenite region have a distinctly lower creep strength. In this connection it is interesting to consider the influence on creep strength that is produced by changing the amounts contained in each of the two phases in a two-phase alloy.

This was studied by means of a series of alloys containing 25% chromium and from 4 to 16% nickel. The amount of austenite in this series ranged from 0 to 100% with increasing nickel content. The creep strength increased linearly with increase in the amount of austenite (γ-phase) as shown in Fig. 2. It is

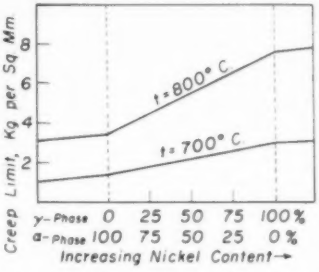
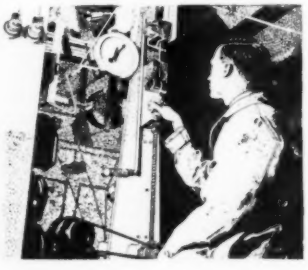


Fig. 2 — Effect of Increasing Nickel Content From 4 to 16% in a 25% Chromium Alloy on the Stress Needed to Produce a Creep Rate of 10^{-4} per Hr.

unlikely that much of the observed increase was caused by the increasing nickel content.

The properties of the sigma phase were found to be closer to those of ferrite than to austenite. Thus, the presence of this phase caused a decrease in the creep strength of the austenite phase.

A. G. Guy



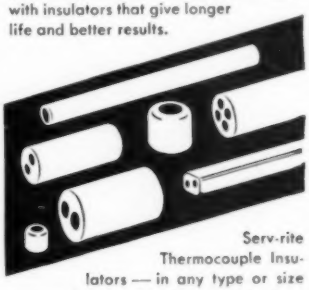
Be Certain WITH "SERV-RITE"

THERMOCOUPLE INSULATORS

This Gordon Thermocouple Insulator, heated red hot and plunged into cold water, came out just as good as new

Available only through GORDON, Serv-rite Thermocouple Insulators are made to stand the gaff of excessive thermal shock far above normal requirements.

For sturdy and reliable thermocouple insulator performance to meet peak production needs—specify Serv-rite . . . a development backed by Gordon's many years' experience in supplying industry with insulators that give longer life and better results.



Serv-rite Thermocouple Insulators — in any type or size — can be supplied immediately from Gordon's large stocks in the Chicago and Cleveland plants. Remember — you can always distinguish Serv-rite Insulators by their tan color.

Fish Spine Beads	Asbestos String
Asbestos Tubing	Single Hole
Double Hole Round	Double Hole Oval

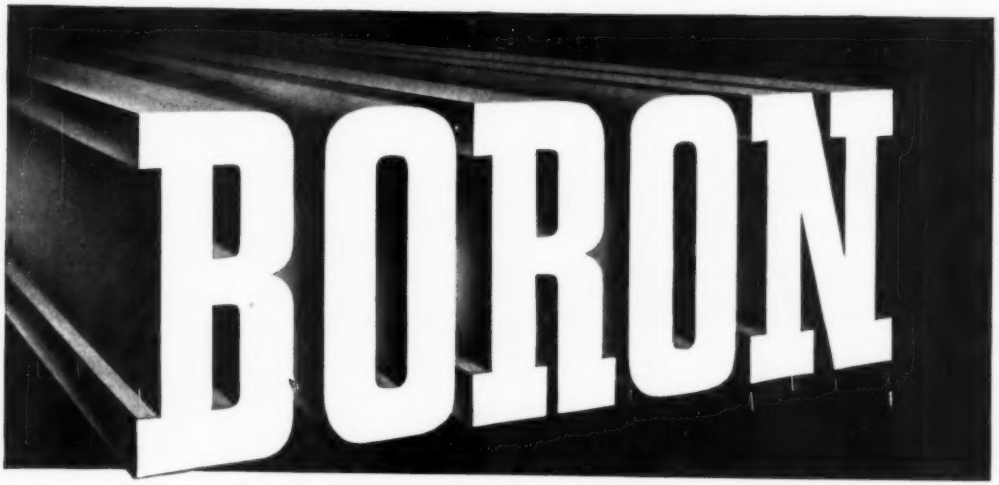
GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines

Dept. 15 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 15 • 2035 Hamilton Ave., Cleveland 14, Ohio



One Way to Ease the Alloy Situation

"Boron is used in steel for one purpose only—to increase the hardenability; that is to increase the depth to which the steel will harden when quenched." — The Metals Handbook of the ASM.

An acute shortage of alloying elements exists because the nation has been producing steel at record-breaking rates, and because the present military aircraft program demands steels of much higher alloy content than were needed in World War II.

One way to ease this shortage appears to be a broader understanding and acceptance of boron steels. These steels are now being used effectively to replace many of the rolled constructional alloy grades, where hardenability is the chief consideration. Boron is readily accessible, and when used in extremely small quantities it increases the hardenability effects of the other alloying elements.

Boron also provides certain added advantages. It reduces the percentage of the other elements needed, and thereby improves the cold-working quality of the steel. It also improves machinability to some extent.

If you are considering the use of boron steels for any purpose where you formerly used high-alloy steels, get in touch with Bethlehem. Our metallurgists will advise you as to analyses and proper heat-treatment.

We produce boron steels as well as regular alloy, special, and carbon steels.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

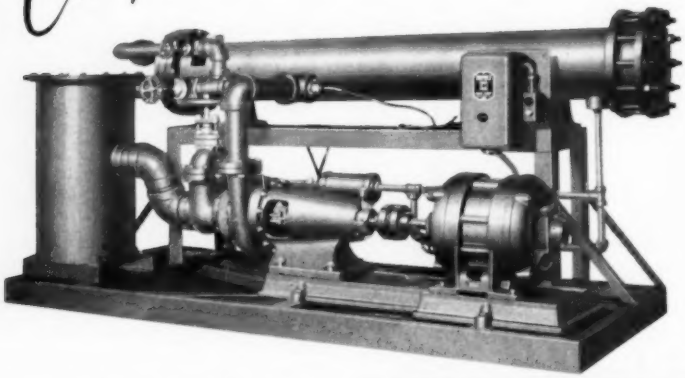
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM ALLOY STEELS

BETHLEHEM STEEL

Completely Self-Contained B&G OIL COOLERS...

or build your own from component parts



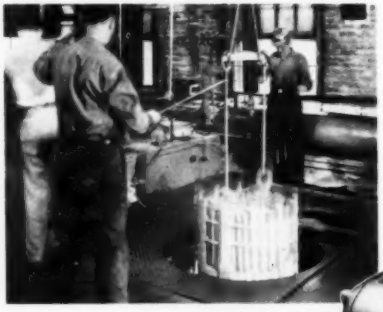
The B & G Self-Contained Oil Cooler illustrated here is pre-engineered and assembled complete at the factory. It eliminates the need for building pump piers and stands and for assembling pipe, valves, controls and wiring. Your only responsibility is to place the unit in position and connect it to the quench tank and water lines. It can be easily moved if a change in plant arrangement makes it necessary.

If you are having too many rejects because of warping or variations in quality, *look into your quenching methods!*

B & G *Hydro-Flo* Quench Oil Cooling Systems are installed the country over because of demonstrated ability to maintain desired characteristics in the finished product. Heated metal is brought down from furnace temperature to the correct end degree with unfailing accuracy. Each batch is quenched under *identical* conditions and hence is *identical* in quality.

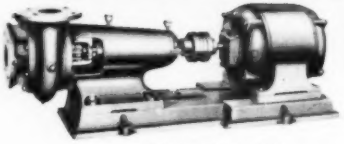
Whatever your quenching problems, B & G engineers are ready to lend a hand. A complete system can be designed to fit your specific requirements. At your option, the system will be delivered as individual units or factory-assembled, ready for operation.

Write for information.



B & G
Quench Tank

B & G Series 1522
Centrifugal Pump



B & G Series 1510-15
Centrifugal Pump

B & G
Oil Cooler

Hydro-Flo® OIL QUENCHING SYSTEMS

BELL & GOSSETT COMPANY

Dept. CK-16, Morton Grove, Ill.

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto

®Reg. U. S. Pat. Off.

FULL BORON EFFICIENCY with Grainal Alloys

Grainal is a more reliable means of making boron steels because the titanium, aluminum, zirconium and manganese in the alloy perform an important part of the treatment.

Grainal treatment is able to compensate for variations in oxygen and nitrogen contents of steel and for differences in finishing practice, thus effecting the proper treatment of steels by means of boron-containing alloys and providing constant benefit to properties.

Uniform results are obtained from one shop to another without the necessity of using identical steelmaking practices.

VANADIUM CORPORATION OF AMERICA
420 LEXINGTON AVENUE, NEW YORK 17, N. Y. • DETROIT • CHICAGO • CLEVELAND • PITTSBURGH
MAKERS OF ALLOYS
VANCORAM
CHEMICALS AND METALS

RARE EARTH" materials, which have commanded great and growing interest even as imported from foreign sources, can now be produced in abundance within the United States.

The Molybdenum Corporation is able to report that highly modern facilities are being installed and rapid growth provided for. Technical research, looking toward new and better employment of these materials, has been extensive and will continue. Consultation with present or prospective users is invited.

As a supplier of Molybdenum, Tungsten, Boron, and other alloying materials, the Molybdenum Corporation welcomes correspondence on any application or requirement.

AMERICAN Production, American Distribution, American Control, Completely Integrated

Offices: Pittsburgh, New York, Chicago, Cleveland, Detroit, Los Angeles, San Francisco

Sales Representatives: American Steel and Supply Co., Chicago; Edgar L. Fink, Detroit; Brumley-Donaldson Co., Los Angeles, San Francisco

Subsidiaries: Cleveland-Tungsten, Inc., Cleveland, O.; General Tungsten Manufacturing Co., Inc., Union City, N.J.

Works: Washington, Pa.; York, Pa.

MOLYBDENUM **CORPORATION OF AMERICA**
Grant Building Pittsburgh, Pa.

MCA

SMALL LOAD of bars ready for Virgo bath. Bars will then be quenched, dipped in dilute acid, and hosed clean. Total processing time: 11 minutes.

DESCALE, DESAND, DEGRAPHITIZE IN 11 MINUTES

with VIRGO® Descaling Salt VIRGO® Molten Cleaner

The Hooker Process for descaling stainless and alloy steels and for cleaning ferrous metal of any type is the quickest, simplest available.

Use this Process on all forms of steel; castings; forgings; fabricated parts; material to be salvaged. It gives you a chemically clean, bright metal surface—with full dimensional stability—in minutes.

The Process is non-electrolytic . . . non-toxic . . . uses simple equipment . . . does not require close control . . . is easily adapted to your production methods. For full details, mail the coupon or write us today.

SEND FOR THESE BULLETINS . . . get the whole story on Virgo Descaling Salt and Virgo Molten Cleaner—what they are, how they work, their advantages, how they fit your operations, and the Hooker services you enjoy as a user of the process. Send for these bulletins today.

VIRGO DESCALING SALT—quickly, positively removes hard-to-touch scales produced on stainless and alloy steels by hot rolling, forging, extruding, casting, annealing.

VIRGO MOLTEN CLEANER—quickly, positively desands and degraphitizes castings; removes grease, dirt, chemicals, paint, rubber, enamel, atmospheric corrosion and other impurities from all alkali resistant metals.

WE HELP YOU with 15 years' experience in molten salt bath descaling and cleaning. Complete engineering, research, sales, and on-site operating assistance are part of our service.

Hooker Electrochemical Company
30 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

Please send me Bulletins on Virgo Descaling Salt and Virgo Molten Cleaner.

NAME_____

TITLE_____

ADDRESS_____

COMPANY_____

CITY_____ ZONE____ STATE____

HOOKER CHEMICALS®

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

30 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.
NEW YORK, N. Y.
WILMINGTON, CALIF.
TACOMA, WASH.

1-1444

"Our Special Alloy Welding Department is Built Around the **OLSEN** *Super L"*

So says the chief welding engineer at The Sharples Corporation, leading manufacturers of continuous centrifuges for industry.

Welding a wide variety of metals, including monel, stainless steel, aluminum, and other ferrous and non ferrous materials, Sharples is required to meet the most exacting physical, chemical, and metallurgical requirements in their welds.

"We set up a research program to establish and prove our welding procedures and techniques with the aid of our Olsen Super L equipped with electronic extensometer and electronic recorder. Then we run daily production control test specimens. The SelecTrange indicating system, ability to change ranges during test, and simple extensometer attachment all help to make our weld testing a simple procedure."

These comments are typical of those we receive from many users of the Olsen Super L. We'll be glad to discuss your testing machine needs.

The Olsen tradition... testing is our business.

TINIUS OLSEN

Testing & Balancing Machines

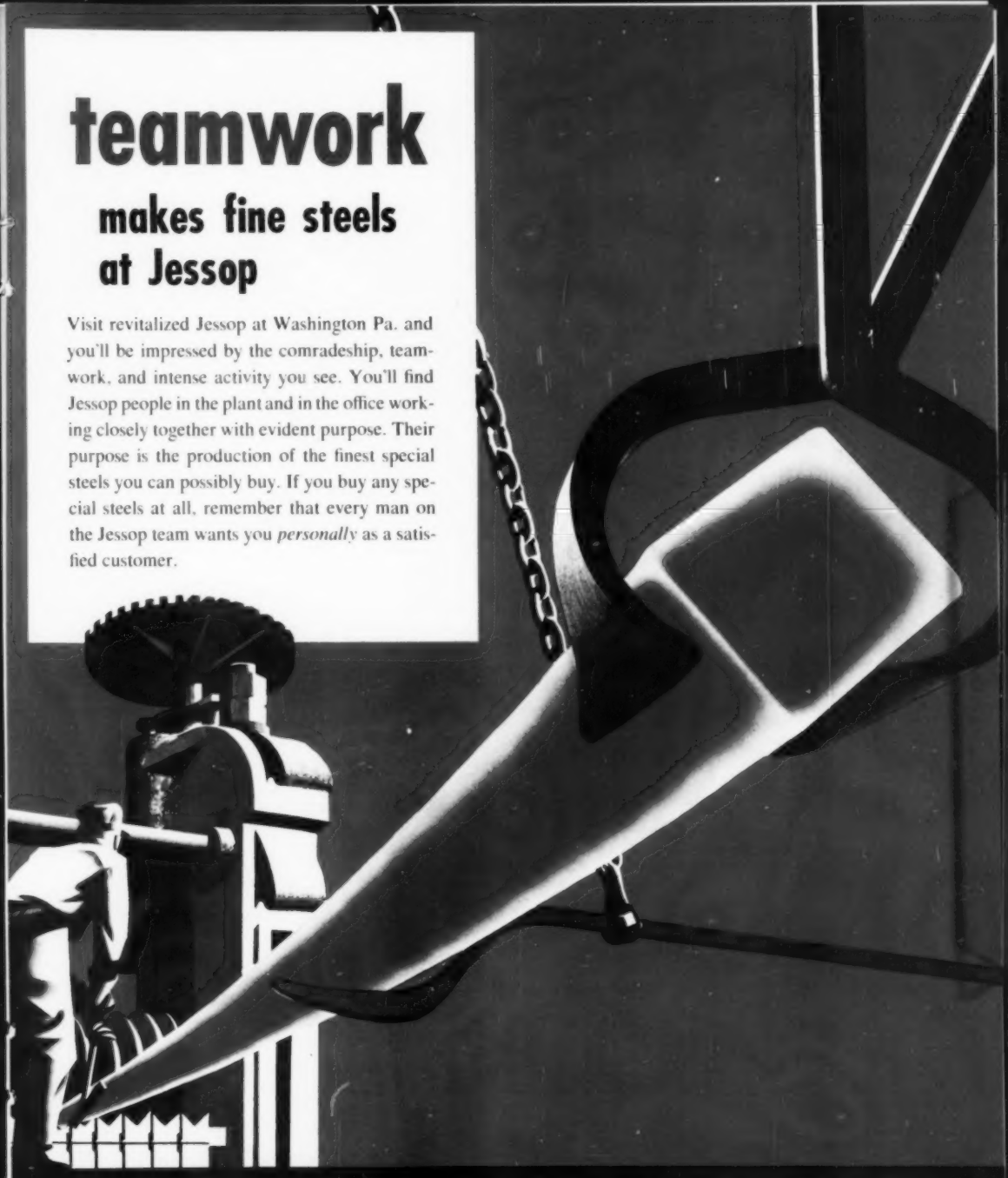
TINIUS OLSEN TESTING MACHINE CO.

2030 Easton Rd., Willow Grove, Pa.

teamwork

makes fine steels at Jessop

Visit revitalized Jessop at Washington Pa. and you'll be impressed by the comradeship, teamwork, and intense activity you see. You'll find Jessop people in the plant and in the office working closely together with evident purpose. Their purpose is the production of the finest special steels you can possibly buy. If you buy any special steels at all, remember that every man on the Jessop team wants you *personally* as a satisfied customer.

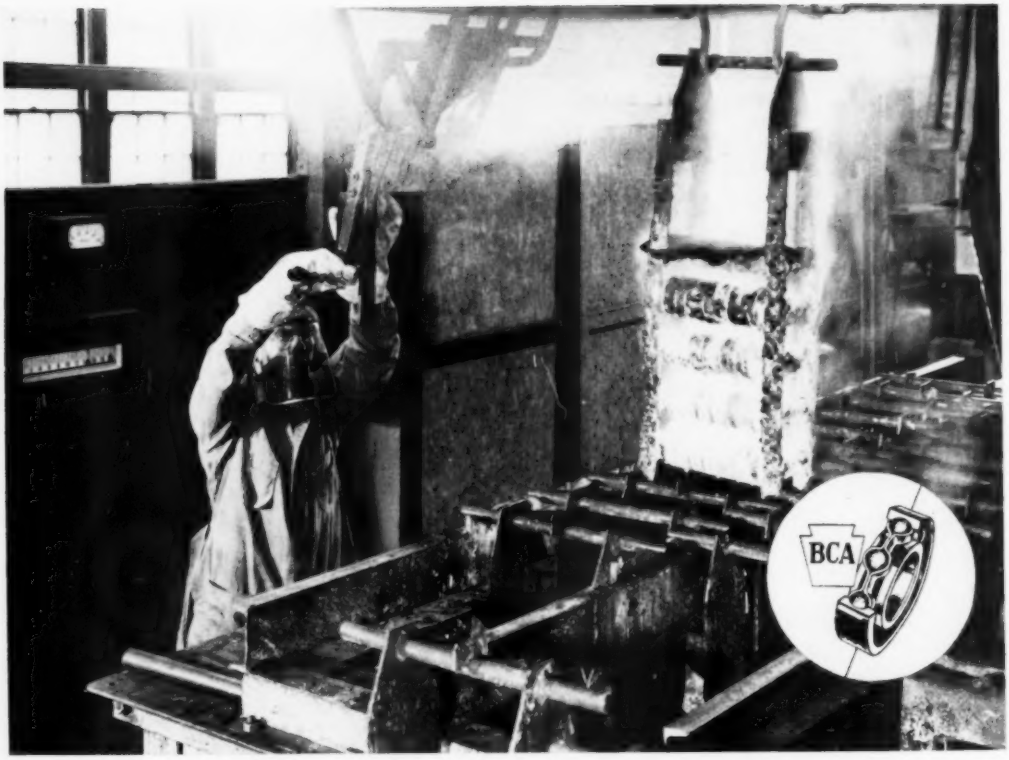


high speed steels
high speed bits
precision ground flat stock
high speed and alloy saw steels
hot work die steels
cold work die steels

carbon and alloy steels
stainless and heat resisting steels
valve steels
stainless clad steels
cast-to-shape steels
composite tool steels
armor plate

JESSOP

STEEL COMPANY · WASHINGTON, PENNSYLVANIA



Conversion to liquid carburizing saves 6,000 sq. ft. of space . . . triples productive capacity

JUST TWO compact, liquid carburizing units have replaced *twenty-five* pack carburizing furnaces at Bearings Co. of America, Lancaster, Pa. These space-saving units require 6,000 sq. ft. less floor area and have increased production by almost 300%! Conveyorized bath operation reduces tedious manual handling . . . produces deep cases of exceptional uniformity on ball bearing races.

More and more plants are converting to liquid carburizing for high quality case hardening at low cost. They're finding that this efficient process reduces the danger of overheating by permitting accurate control of carburizing temperatures . . . greatly lessens the problem of distortion . . . and provides fast, uniform heating that insures cases of maximum uniformity—even when parts have extremely irregular sections!

Perhaps your plant can profit by converting to a molten salt bath process. Get in touch with your nearest Du Pont office today. Our technical representatives will be glad to study your problem and help in the selection of materials and the planning and layout of equipment. E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

• • •

There's a Du Pont molten salt bath for every heat treating need. Sodium Cyanide, Accelerated Salt WS,* and Carburizing Salt—for shallow, medium and deep cases—are just three of the Du Pont heat treating materials that can mean top production and maximum economy for your plant.

Water Soluble

DU PONT
CYANIDES and SALTS
for STEEL TREATING

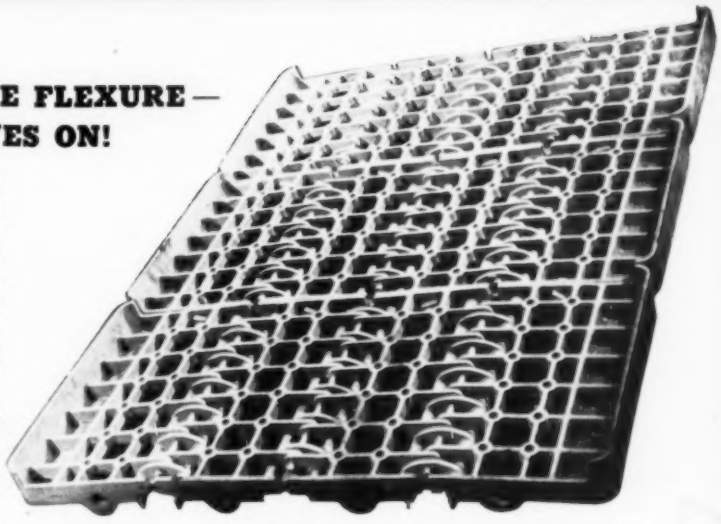
DU PONT
REG. U.S. PAT. OFF.

150th Anniversary

Better Things for Better Living . . . *through Chemistry*

ELECTROCHEMICALS DEPT. DISTRICT OFFICES:
Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, El Monte (California), New York, Philadelphia

THE HINGE TAKES THE FLEXURE— AND—THE ALLOY LIVES ON!



The above triple-hinge tray (HHH Patent Pending) clearly illustrates the hinge principle which extends multiple life to Q-Alloy and X-ite work carrying trays in pusher-type furnaces. Thousands of these are in use.

The trays shown, currently in use in the plant of Wyman-Gordon Company, Worcester, Massachusetts, each have a complete assembled weight of 36 lbs. Such designs can carry up to ten, or even twenty, times their weight (depending upon the length of push and operating temperature) in annealing, normalizing, carburizing and all heat treating operations. Similar trays at lighter loads are operating at 2250° in sintering and powder-metallurgy processes.

No patented design in the history of heat treating, in alloys, or furnaces, has been so widely used or has so clearly demonstrated service economies and mechanical advantages. Many attempts to "get around" the patent by employing various articulations as bastardized "hinges"—a number of them with self-destructive leverages—have produced inferior trays.

Nowhere does the intellectual limitation of a "designer", or the mediocrity of his employer, become so obvious as in "imitations". G. A. is an Engineering organization, not a "foundry". All casting practice, even the "gating" of every individual pattern, conforms to executive engineering policy, is not left to shop supervisors.

The HINGE idea is *fundamental* and *simple*. No furnace rails, brickwork or rough castings were ever truly "flat" or "straight". Even a ground alloy surface plate would distort in a heat treating operation. There is no such thing as even approximate three-point line support at high temperatures. A tray being pushed through a furnace on three rails is, actually, principally carried on *two*, except as it bends to make contact with the third. In traveling through a furnace, it is obvious that three parallel rails provide *intermittent* and *alternative* support, resulting in the *bending of trays*. Such bending creates *fatigue* and premature *failure*. IF SOMETHING HAS TO *BEND*, PUT A *HINGE* IN IT—*JUST COMMON HORSE SENSE!*

Some furnaces (*usually the "low bidders"*) employ two rails with excessively wide span. Often, under-designed "cheap" alloy trays are included in furnace deals to cover two profits on trays and still meet a price. G. A. does a large business replacing "flimsy", short-lived "package deal" trays in pusher furnaces.

Elementary engineering knowledge indicates the material saving by halving the span of a beam.

Wherever possible or practical, on any but the very lightest loads, we recommend three or more rails and hinge trays. In a plant producing a World Standard automobile, hinge trays showed five years' life, where "articulated" trays had 100% replacement in one year.

General Alloys' engineers have (from unequaled experience) a unique understanding of stresses, fatigue life and the *over-all integration of design, function and casting practice*. Controlled structure-chemistry relation and grain-size-related-to-function are advanced *exclusive* G. A. developments *in production*.

ENGINEERING AND ADVANCED CASTING PROCESS CONSERVES ALLOYS FOR DEFENSE

With nickel and chrome rationed, it is obvious that you can get *more* and better alloy tooling for your heat treat only by fully utilizing *advanced* Engineering and casting practice to reduce alloy weight to a minimum. Thus, *each pound of alloy does maximum work, lives longer!*

Hinge trays are typical of many General Alloys' advanced designs. If you buy on *service rendered*, rather than first cost, we solicit your inquiries.

REPORT ON JAGUAR XK-120 (yet many requests)

After two years, we have opened the "Jag" engine for the first time. The motor was untouched since we bought her—the Show Car in Chicago in February 1950. We opened the motor to install high lift cams, a light flywheel and minor refinements to increase R. P. M. from 5400 to 5800, and H.P. from 160 to 180-190 (with 140 M. P. H. expected).

Engine was "perfect" inside, including all valve gear, valves, auxiliaries and bearings with following minor exceptions:

a) one piston skirt was unaccountably 0.019 under size.
b) one cam follower was functioning O.K., but found to be cracked in five pieces.
c) slight indicated flaking of con-rod bearings.

Universal joint was "shot" because lubrication stupidly inaccessible.

Original water pump was formerly replaced with improved model, account of water loss at high speed.

Car was driven hard by several drivers—spent months in Pacific sun and salt air—navigated deserts and mountains—and, finally, towed the feather-weight 100 M. P. H. trailer back East from California.

"Jag" has magnificently designed engine with higher performance and less maintenance than any fast car we have owned or know of. Twin overhead cams give this sub-Ford-size engine nearly 50% more revs, as much horsepower and vastly more "wham" and acceleration at high speed than our bigger U. S. "modern" engines. Reasons are simple and obvious. Efficiency of an engine as an air pump, its freedom of breathing, getting the *mixture in* and the *exhaust out*, determine its power and efficiency. Getting rid of a dozen or more flip-flopping push rods, rocker arms, and miscellaneous mechanical losses, does the trick.

The same engine in a 4000-lb., four-door sedan just broke all U. S. stock car records in Florida at 108 M. P. H. The spherical cylinder head employed, as well as the overhead cams, are some twenty years old. Nothing original except engineering comprehension is indicated by partial adoption of such obvious advances in U. S.

Next, we hope, will come U. S. use of "Jags" or other torsion rod front springing and independent rear suspension. Shortcomings of U. S. spring suspension and braking were forcibly revealed in Mexican road race. In this department, we are making progress. Road holding, springing and braking on Jaguars are outstandingly superior to U. S. "family" cars, in point of safety and handling. They are not the best, being exceeded by Ferrari and others.

In basic mechanics the Jaguar is a *jewel*, but in construction is full of petty flaws, stupid detail, and poor materials. Cooling is inadequate. Inferior metallurgy in fatigue-failed generator brackets, housing bolts, etc., is obvious. Bad paint, poor materials, inaccessible and non-functional stuff and poor workmanship are evident in many places—*stuff that wouldn't be tolerated on a low-priced U. S. car*. Replacement parts are overpriced and poorly stocked. Excellent service is available in a few places but service manual, promised in catalog, is still not available.

In conclusion, we wouldn't sell the XK-120 for *twice her cost*—if we couldn't get another. If any U. S. manufacturer should find it profitable to build such a car in volume production, he would do a far better job.

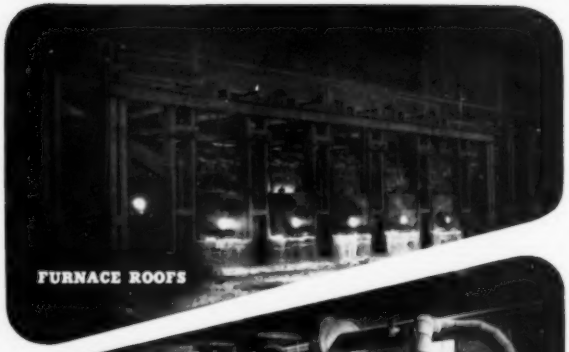
H. H. Cornell

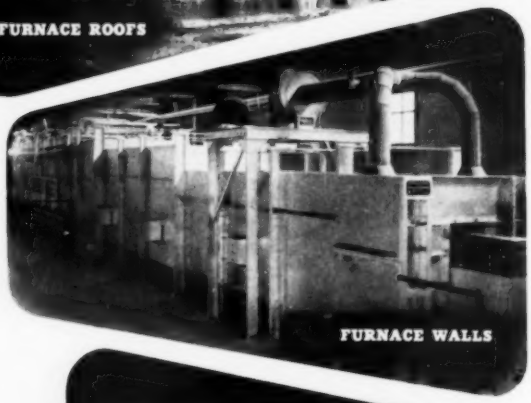
An "editorial" by the President of General Alloys Company, "Oldest and Largest Exclusive Manufacturers of Heat and Corrosion Resistant Castings"—Boston, Mass. Offices in principal cities.

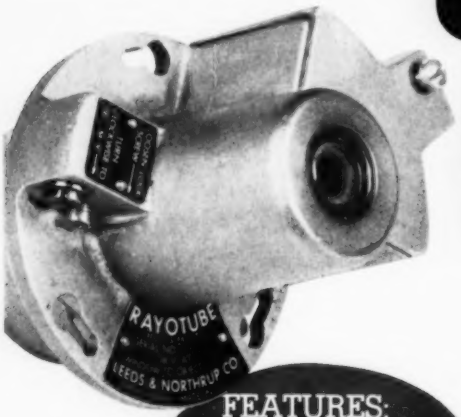
THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

GA X-ITE GA CHALLOYS GA X-ITE GA CHALLOYS

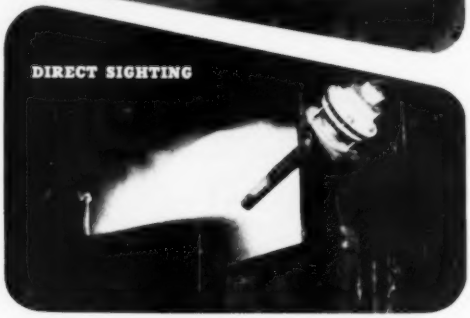
This RAYOTUBE suits all locations COOL OR HOT







FEATURES:
Quick installation
" sighting
" response to temperature



Here is the radiation-sensing unit for 9 out of every ten radiation-pyrometer uses. It adds the storekeeping advantages of smaller instrument inventory to the operating advantages* of all Rayotubes. Many hundreds of this type are now in use. Among its features:

1. Easy to install because it needs no water-jacket unless the head housing itself (shown above) reaches interior temperature of 350 F. Even then, no harm is done below 450; accuracy decreases above 350, but returns fully as temperature drops. In practical operation, even 350 is reached on very, very few installations.

When replacing a present jacketed Rayotube with this type, it is not necessary to tear out the jacket and piping. Simply insert Rayotube in jacket and turn off water if no longer needed.

2. New, quick-sighting optical system shows exact area from which temperature is being recorded. This is especially helpful when instrument is being positioned to point down an open-end tube and measure directly the surface temperature of parts being heated.

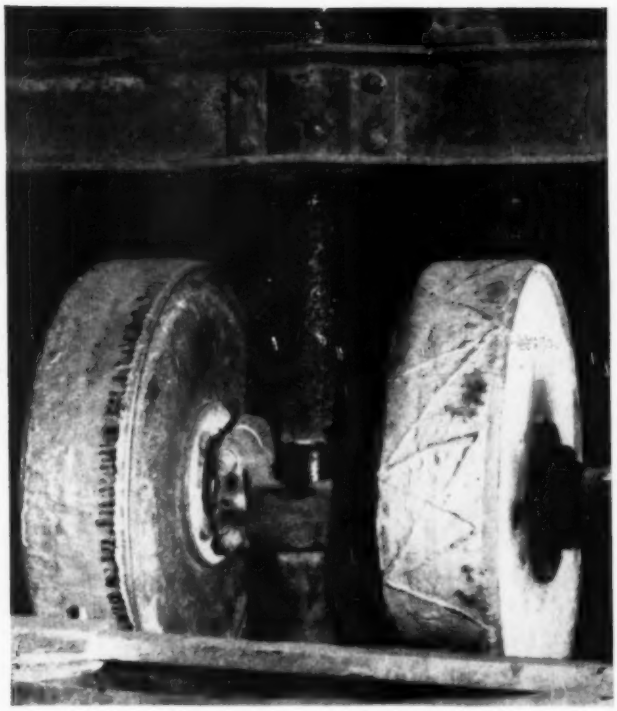
3. Can be used with Speedomax electronic instruments as well as with Micromax equipment—which blanket every temperature-recording and/or controlling job in industry.

This Rayotube is No. 8890. Any L&N office, or headquarters at 4927 Stenton Ave., Phila. 44, Pa., will send details on request.

*Any L&N man can give details

LEEDS & NORTHRUP
MEASURING INSTRUMENTS · AUTOMATIC CONTROLS · TELEMETERS
HEAT-TREATING FURNACES

Jul Ad N8(3)



6 Years on the Rock Pile ...and STILL SERVING TIME!

These hard-faced rock-crusher rolls have already outlasted unprotected rolls 12 times—and they are still in operation.

The hard-faced rolls on this rock-crusher mill have been in constant operation for six years. During this time, the rolls have been pulverizing such abrasive materials as ferro-alloys, ore, dolomite, feldspar, rock, sand, and clay used for making brick. Unprotected rolls, performing the same operations, had to be replaced every four or five months.

The serrated roll shown at the right in the photograph is the roughing roll used for initial grinding or milling. The smoother roll, at the left, is a finishing roll used to grind the abrasive materials into a powder. Both rolls were hard-faced with HAYNES STELLITE alloy by the metallic-arc process to protect them from abrasion.

The new 40-page booklet, "HAYNES Alloys—Hard-Facing Manual," gives the whole story on hard-facing. It includes information on what metals can be hard-faced, how to select the right HAYNES hard-facing material, step-by-step application procedures, and a list of typical industrial applications with recommended rods for each. If you would like a copy of this booklet, write to our nearest district office.

HAYNES TRADE-MARK *alloys*

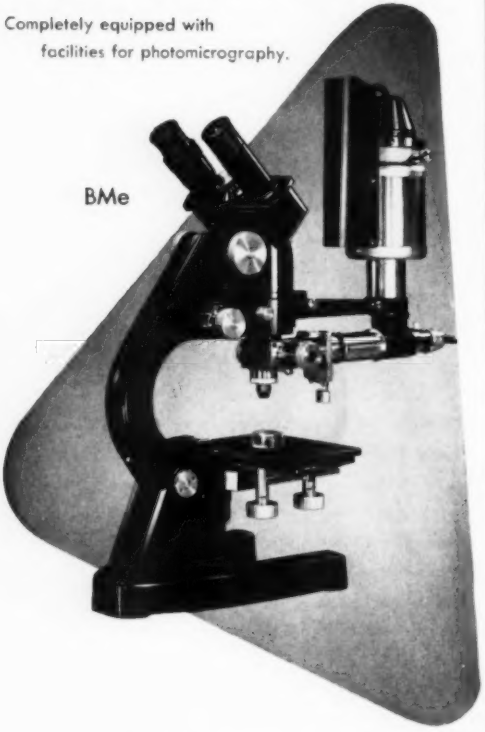
"Haynes" and "Haynes Stellite" are trade-marks of Union Carbide and Carbon Corporation.

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

The new Leitz Metallurgical Microscope

Completely equipped with facilities for photomicrography.

BMe



For information, see your Leitz franchised dealer, or write to Dept. MP 106

E. LEITZ, Inc., 304 Hudson Street, New York 13, N. Y.

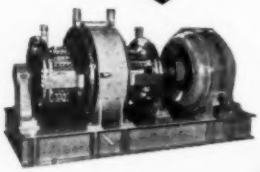
LEITZ MICROSCOPES • SCIENTIFIC INSTRUMENTS
BINOCULARS • LEICA CAMERAS AND ACCESSORIES

COLUMBIA

MOTOR GENERATORS

for

Electroplating
Anodizing
Electrocleaning
Electropolishing



TONG TEST AMMETERS

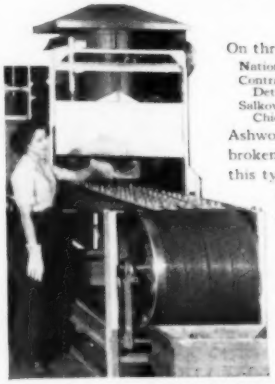
- REVERSING SWITCHES
- TANK RHEOSTATS

Write for Descriptive Bulletins

COLUMBIA ELECTRIC MFG. CO.
4531 Hamilton Ave. • Cleveland 14, Ohio

For Brazing at 2050° F.

Woven Wire Belts built by ASHWORTH are breaking records . . .



On three different installations
National Stamping Company, Detroit
Contract Specialties Corporation, Detroit
Silkover Metal Processing of Illinois, Chicago

Ashworth built Wire Belts have broken all previous records for this type of service, running up *to 7,000 and 8,000 hours at 2050 F.*

WHAT IS YOUR HANDLING or PROCESSING PROBLEM?

WRITE FOR ILLUSTRATED CATALOG 47P

ASHWORTH BROS., INC.
METAL PRODUCTS DIV. • WORCESTER, MASS.

Sales Engineers located in Buffalo • Chattanooga • Chicago • Cleveland • Detroit Los Angeles • New York • Philadelphia • Pittsburgh • Seattle
Canadian Rep., PECKOVER'S LTD. - Toronto Montreal - Halifax - Winnipeg - Vancouver

Here's why

it pays to know your

HSM

HONEYWELL SUPPLIES MAN

Made to highly uniform wall thickness, Brown thermocouple protecting tubes are supplied in a variety of metals, alloys and refractory materials . . . in a wide selection of sizes and styles from which your HSM can select the right one for your application.

R. C. SHUMACHER, Honeywell Supplies Man in the Cleveland area, recommends the correct Brown protecting tube for an angle-type couple in a lead pot at the L. R. Oatey Company . . . after outlining the benefits of the HSM plan for buying pyrometer supplies.

You'll be pleased when you, too, learn how *this plan* can add new convenience and economy to *your* pyrometer supplies purchasing!

There's a Honeywell Supplies Man near you . . . at your local Honeywell office . . . as near to you as your phone. Call him in today . . . let him show you how the HSM plan can work in your plant.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4503 Wayne Avenue, Philadelphia 44, Pa. Stocking points in Philadelphia, Cleveland, Chicago, Atlanta, Houston, Los Angeles and San Francisco.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

● *Important Reference Data*

WRITE FOR NEW PYROMETER SUPPLIES BUYERS' GUIDE NO. 100-4.

The lowest cost corrosion-resistant fasteners you can buy

If your aluminum assemblies call for corrosion-resistant fasteners, you can save by specifying Alcoa Aluminum Fasteners. A complete line of quality screws, bolts, nuts, washers and rivets to choose from.

ALUMINUM COMPANY OF AMERICA
1925C Gulf Bldg.
Pittsburgh 19, Pa.

ALCOA

Fasten Aluminum with Alcoa Aluminum Fasteners

"SEE IT NOW" with Edward R. Murrow brings the world to your armchair... CBS-TV every Sunday • 3:30 PM EST

NEW MOGUL
SOLDERING
AND BRAZING GUN

This new MOGUL unit is built to deposit lead and tin base solders, silver solder and brazing wires in a liquid or semi-liquid form to any constant moving part.

High or Low Speed. Moving part travels at desired speed, as Gun adjusts to your specific application.

Pinpoint Location. Deposits solder or brazing wire to exact spot for clean seam . . . material saving.

Extremely Versatile. Use Gun for constant or intermittent work of any type, regardless of shape, joints, connections, terminals or seams. Seam soldering speeds up to as much as 200 lineal ft. per min.

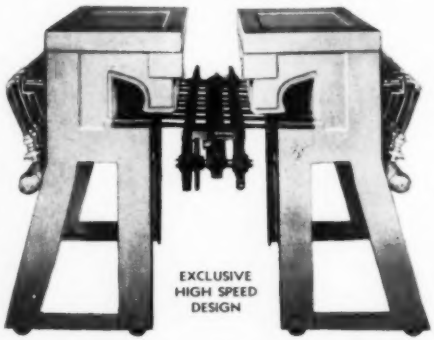
Saves Time • Saves Solder

Recent installation of a Mogul Gun afforded a reduction of 75% in labor costs plus appreciable solder savings. Perhaps Mogul can do the same for you. Write today for full information.

METALLIZING COMPANY OF AMERICA
Dept. MP, 3520 West Carroll Ave., Chicago 24, Illinois

Doubles End Heating Output on Bar Stock

G.A.S. ROTO-FLAME FURNACE



The above installation shows how a leading automotive spring maker revolutionized spring leaf production in his plant by using 2 units . . . thus heating both ends of flat bar stock simultaneously before swaging (or eye-curling) operation.

Boosts Production—through much faster heating . . . uniform control . . . uniform temperature.

Cuts Operating Costs—Operation can be made fully automatic . . . saves fuel . . . saves labor . . . saves 75% floor space . . . prolongs die life.

Provides Better Working Conditions—Heat concentrated on work . . . not on operator. Utilizes any type of gas fuel.

New Savings in Heating—for forging, swaging, upsetting, threading, hardening, or annealing. Ask for Bulletin No. 350.

GAS APPLIANCE SERVICE, INC.
Industrial Gas Engineers
1201 WEBSTER AVENUE • CHICAGO 14, ILLINOIS

from stem to stern!

. . . the most reliable refractory boat available today

THE *New* FISHER COMBAX

COMBUSTION BOAT

for determinations of carbon and sulfur in steel.

Here's why Fisher Combax Combustion Boats are more reliable:

Denser—high zircon content produces amazing resistance against penetration of molten metal, increased mechanical strength, greater thermal shock resistance.

Carbon and Sulfur Free—Carefully selected raw materials and exact firing techniques produce blank-free boats which make pre-burning unnecessary.

Sealed Packages—boats are packed in de-greased, unlacquered metal containers sealed at the factory. No contamination from packing liners or hand contact before the boats reach the laboratory.

Extensive research has resulted in a much better combustion boat. Greater body density, new blank-free specifications, latest mechanical packaging facilities combine to provide boats and covers that will bring a new order of accuracy to carbon and sulfur determinations.

Headquarters for Laboratory Supplies

FISHER SCIENTIFIC COMPANY

PITTSBURGH • 717 Forbes (19) | NEW YORK • 635 Greenwich (14) | WASHINGTON • 7722 Woodbury (Silver Spring, Md.) | ST. LOUIS • 2850 S. Jefferson (18) | MONTREAL • 904 St. James

Want to use the best boats?

WRITE FOR FREE SAMPLES

Fisher Scientific Company,
717 Forbes St., Pittsburgh 19, Pa.

Please send me, without cost or obligation, a sample package of the new Fisher Combax combustion boats and covers.

Name _____

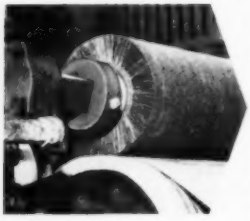
Company _____

Address _____

How Pittsburgh Brushes

SPEED PRODUCTION

1. Removing oil film from steel!

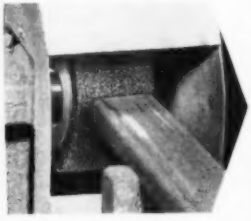


Crown Cork & Seal Co., Inc., asked Pittsburgh engineers to recommend a brush suitable for washing oil film from steel before annealing. A "built-up" brush made of Tampico sections was installed. Oil and foreign matter were completely removed without harming the surface of the steel. Production showed an immediate increase, and time saved due to fewer brush replacements added to the overall savings.

2. Satin-finishing brass fixtures!

Frequent breakdowns and brush changes hampered Bastian-Blessing Company's production of satin-finish parts for its products. Pittsburgh engineers recommended a crimped steel, standard 10" brush. Reports after three years' use show Pittsburgh Brushes have increased production, improved quality and saved materials . . . while lasting *three times longer* than previous brushes!

3. Removing burrs from steel!



Problem: The National Electric Company needed a brush to eliminate burrs and scale, yet the brush had to combine cleaning ability with long life. Solution: Pittsburgh designed a brush to specifications—a brush that was stiff and tough enough to penetrate, clean, and remove burrs and scale, and rugged enough to stand up. Result: An increase in efficiency; a jump in production!

Let Pittsburgh Engineers Solve Your Brush Problems. Pittsburgh's complete line of brushes of every type, for every purpose, will provide a practical and economical solution of any brush problem you might have. Drop us a line on your company letterhead for a copy of our new booklet that shows, through actual case histories, how Pittsburgh brushes help cut your operating costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-7, 3221 Frederick Ave., Baltimore 29, Md.

PITTSBURGH

Power Driven

BRUSHES

BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS

PITTSBURGH PLATE GLASS COMPANY

Accurate Temperatures

AT A GLANCE WITH THE SIMPLIFIED

PYRO OPTICAL PYROMETER

Any operator can quickly determine temperatures on minute spots, fast-moving objects and smallest streams. Completely self-contained. No calibration charts or accessories needed. An accurate, direct reading Pyrometer that pays for itself by helping prevent spoilage. Weighs 3 lbs. Available in 5 temperature ranges (1400° F. to 7500° F.). Ask for *free* Catalog No. 80.

The Improved PYRO SURFACE PYROMETER

handles all surface and sub-surface temperature measuring jobs. Has selection of 8 types of thermocouples: all interchangeable in seconds with no recalibration or adjustment.

Automatic cold end compensator. Shock, moisture and dust-proof. Accurate, big 4¾" indicator. Available in 5 temperature ranges.

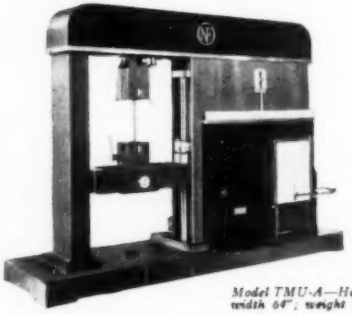
ASK FOR FREE CATALOG No. 165

The Pyrometer Instrument Company

New Plant and Laboratory **BERGENFIELD 8, NEW JERSEY**

Manufacturers of Pyro Optical, Radiation, Immersion and Surface Pyrometers for over 25 years

Make Your Own Tests in Your Plant Save Time and Test Costs . . .



Model TMU-A—Height 44", width 64", weight 1200 lbs.

NATIONAL FORGE Universal Testing Units

Simple to operate — no special training required, these sturdy universal testing machines are dependable and moderately priced.

Wide working clearances, long stroke, quick-action simplified variable speed control, improved grips and a wide spread of load scale ranges adapt this modern, streamlined unit to production, research or school instruction tests of a great variety of materials and specimen sizes. A.S.T.M. accuracy requirements are guaranteed.

Three load scale ranges: Model TMU-A — 0-30,000, 0-6000, 0-600 lbs. Model TMU-B — 0-15,000, 0-3000, 0-300 lbs.

Prompt Deliveries. For details, write for Brochure 501

Testing Machine Division

NATIONAL FORGE & ORDNANCE CO.

Dept. MP **IRVINE, WARREN COUNTY, PENNA.**

Have you heard about

INCOLOY

(32 Ni.—21 Cr.)

...Inconel's high-temperature companion alloy

Designers know they can get good high temperature resistance and toughness in Inconel®. But NPA has forbidden its use in many applications.

However, it now has a new companion alloy—Incoloy®!

Here's what you get in high-temperature Incoloy:

1. A composition of 32% Nickel and 21% chromium.
2. Excellent resistance to oxidation.
3. Strength at high temperatures.
4. Good workability.
5. Fine welding properties.
6. Non-embrittlement.
7. Resistance to sulfidation, green-rot, and molten cyanide salts.

Incoloy is a *new*, specially developed alloy which is expected to be even superior in its resistance to sulfidation and green-rot as well as molten cyanide salts. And more important, its use is permissible in most applications covered in Schedule C to NPA order M-80.

Forms supplied — Incoloy is produced in the usual mill forms—billets, rounds, flats, hexagons, sheet and strip, tubing and wire.

Right now, Incoloy, like other Inco Nickel products, is on extended delivery because of defense needs. So it will pay you to place your order well in advance of anticipated production—be sure to include the necessary NPA rating with full end use information.

And remember, Inco's High-Temperature Engineering Section is ready to help you with your high-temperature problems. Write today for the specially designed High-Temperature Work Sheet to help outline your requirements.

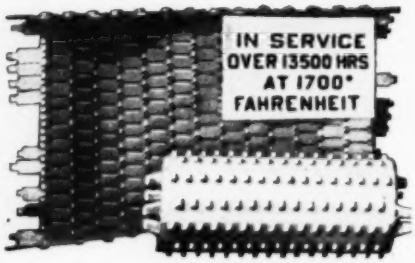
THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

NICKEL (INCO TRADE MARK) ALLOYS

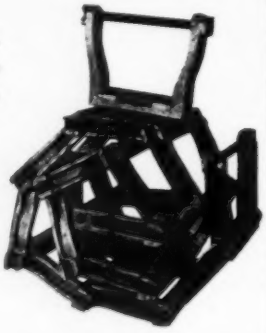
MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"® • INCOLOY® • NIMONICS

HOT SPOTS
require the use of
Pyrasteel PARTS



PYRASTEEL Sprocket and section of Belt Conveyor . . . a typical high-temperature application with a record of exceptionally long service.

PYRASTEEL Drag Chains are widely used in the cement and allied industries. Even when immersed in molten clinker, they do not warp, break or oxidize.



When you need extra durability in high temperature applications, specify PYRASTEEL Parts. This chrome-nickel alloy provides maximum resistance to heat and corrosion at temperatures up to 2000° F., and it also resists corrosive gases and most concentrated or dilute commercial acids.

PYRASTEEL adds to the service life of refinery fittings, furnace parts, conveyor screws, and food and chemical processing equipment.

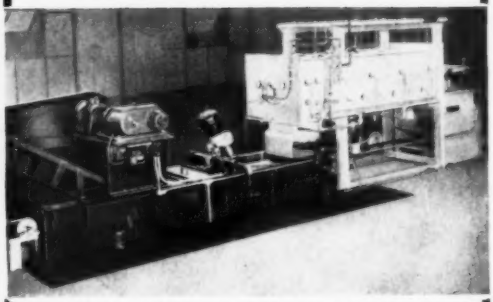
Write for PYRASTEEL Bulletin

CHICAGO STEEL FOUNDRY CO.

Kedzie Avenue and 37th Street • Chicago 32, Illinois

Makers of Alloy Steel for Over 40 Years

CONTINUOUS
HARDENING • QUENCHING



This AGF Model No. 166 Reciprocating Furnace and Quench Tank handles a continuous flow of parts ranging from steel pen points to substantially large finshed parts.

The work is conveyor fed or hand loaded onto the hopper at the right of illustration and then continuously fed through the furnace by reciprocal action, smoothly, positively — the work passes along and into the quench where a mechanically proficient conveyor carries it away.

Write for Bulletins 815 and 820.

AMERICAN GAS FURNACE CO.
1002 LAFAYETTE STREET, ELIZABETH 4, N. J.

KING PORTABLE BRINELL
HARDNESS TESTER

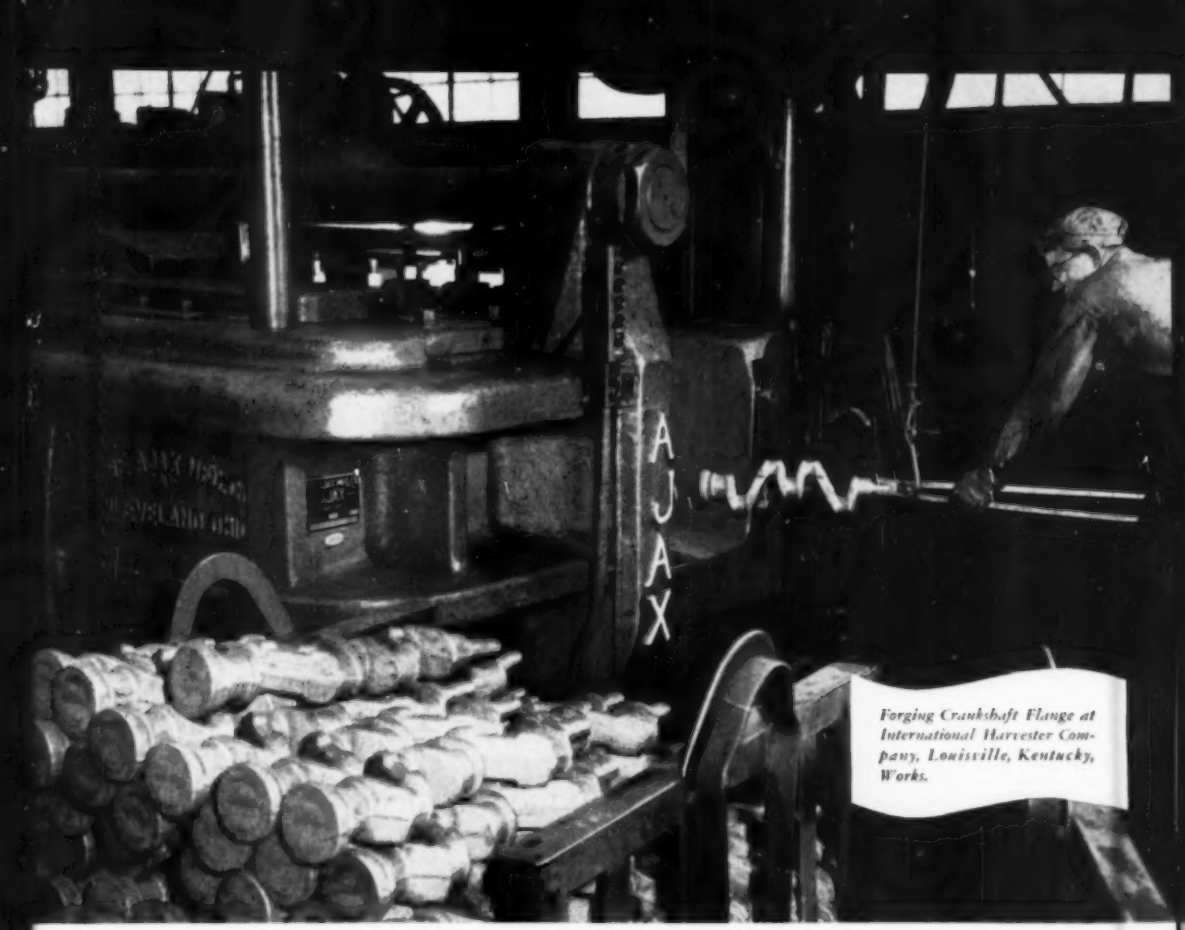
Eliminates excessive material handling costs in routine and special Brinell hardness testing. The King Portable Brinell can be carried to the work, used in any position, and always puts an actual load of 3000 kg. on the 10-mm. ball indenter.

This 27-lb. portable tester has a 4-in. deep throat and a gap 10 in. high. For larger pieces, the test head is easily removable for testing sections beyond the capacity of the standard base.

Throat—4" deep. Gap—10" high. Weight—27 lbs.

Simple to operate, the tester is impossible to overload, and even with inexperienced operators will provide consistent accurate results well within the requirements of the Bureau of Standards.

ANDREW KING
BOX 606 A
ARDMORE, PENNA.



Forging Crankshaft Flange at International Harvester Company, Louisville, Kentucky, Works.

★ Another job for the AJAX Upsetter

In forge shops all over the world, AJAX Upsetting Forging Machines are being chosen as the best piece of hot metal working machinery for a wide variety of jobs in diversified fields of forging. Some forge shop operators favor AJAX Upsetters because of the steady production flow from these air clutch operated machines. Other shop operators may choose the AJAX because the greater rigidity and more accurate alignment provide better filling of the die impressions with a minimum of flash. While still others may be thinking of the saving of the wear and tear on manpower due to the ease of operation.

With all of these important advantages and economies, it is very natural that Ajax Forging Machines continuously maintain a high percentage of productive time.

WRITE FOR BULLETIN 65-C

THE Ajax MANUFACTURING COMPANY

EUCLID BRANCH P. O. CLEVELAND 17, OHIO

110 S. DEARBORN ST. CHICAGO 3, ILLINOIS

DEWART BUILDING NEW LONDON, CONN.

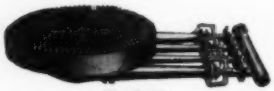
BUZZER Gas BURNERS

For Many Industrial Gas Uses

NO BLOWER or POWER NECESSARY
. . . just connect to gas supply

Pipe Burners

Nozzle Burners



Ring Burners

Designed to solve numerous Industrial Gas applications, "BUZZER" Burners are unexcelled for Efficiency, Economy, Simplicity and Flexibility. Large variety of models available.

Send for the "BUZZER" Catalog showing complete line of Industrial Gas Burners, Furnaces and other equipment.

CHARLES A. HONES, INC.
123 So. Grand Ave. Baldwin, L. I., N. Y.

INDUSTRY LEADERS PROVE HOW YOU CAN **STEP UP**

OUTPUT OF SMALL PARTS

REDUCE MACHINING TIME, COSTS WITH

PRECISION INVESTMENT CASTING

★ ★

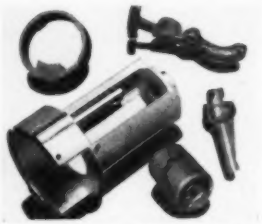


Photo: Arwood Precision Casting Corp.
Intricate, small castings like these are easier to produce, require less finishing

At *Plant after plant*, engineers are finding that they can save on production of high quality, intricate parts by installing precision investment casting equipment.

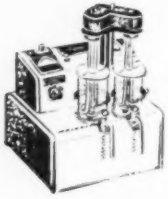
Precision investment casting is particularly suited to quantity output of small parts to close tolerances with fine surface finish.

Let us show you how this new production method can be applied to your own plant, to step up output . . . reduce costs, save time. We will be glad to help you plan a complete investment casting plant . . . or show you how new Saunders equipment will increase the efficiency of your casting operations.

FREE!
Send today for new booklet
MODERN PRECISION INVESTMENT CASTINGS

ALEXANDER SAUNDERS & CO.
Precision Casting Equipment & Supplies
93 BEDFORD ST. WAtkins 4-8880 NEW YORK 14, N. Y.

fabulously fast
metal separation by
DYNA-CATH mercury cathode



New design makes mercury cathode a practical analytical tool. Dyna-Cath does a fast, complete job in separation of metals. Particularly valuable in determination of aluminum in steel and zinc base alloys, other separations. Ask for Bulletin 220-F for details.

Eberbach CORPORATION
ANN ARBOR, MICH.
SCIENTIFIC INSTRUMENTS & APPARATUS

Wanted

ENGINEERS and SCIENTISTS

Unusual opportunities
for outstanding and experienced men.

These top positions involve preliminary and production design in advanced military aircraft and special weapons, including guided missiles.

Immediate positions include:

Electronic project engineers
Electronic instrumentation engineers
Radar engineers
Flight test engineers
Stress engineers
Aero- and thermodynamicists
Servo-mechanists
Power plant installation designers
Structural designers
Electro-mechanical designers
Electrical installation designers
Weight control engineers

Excellent location in Southern California. Generous allowance for travel expenses.

Write today for complete information on these essential, long-term positions. Please include resume of your experience and training. Address inquiry to Director of Engineering.

NORTHROP AIRCRAFT, Inc.
1055 E. Broadway
Hawthorne (Los Angeles County), Cal.

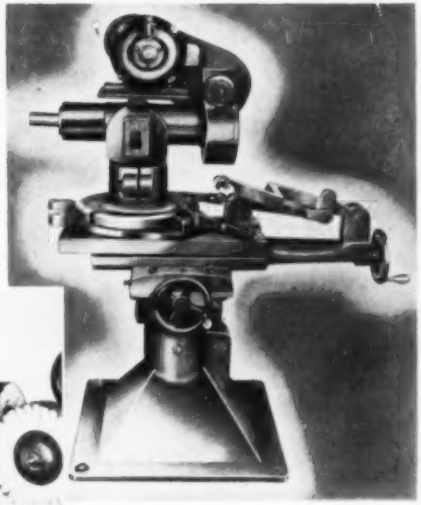
ACME *Automatic*

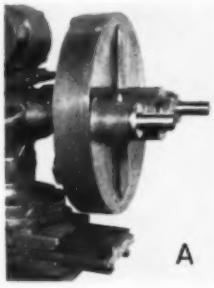
Polishing and Buffing Machines

The ACME Type B-10 Semi-Automatic . . .

IS A VERSATILE PRODUCTION MACHINE

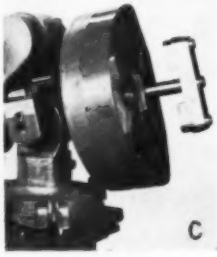
This machine gives very efficient production as one operator normally operates two or more units, one at each end of the lathe, loading and unloading one machine while the other has work in contact with the wheel.





A

B



C

A Type B-10 Equipped with A-2 head handling parts up to 12" diameter. Vacuum chucking available.

B Equipped with Acme patented Geared Chuck which keeps rectangular or other out-of-round work in constant uniform contact with wheel.

Two buffs finishing sides and top in one operation.

C Geared chuck for polishing or buffing faucet bodies. Production up to 240 pieces per hour, one man handling two machines.

This single spindle machine is used with the conventional lathe for finishing such cylindrical parts as cooking utensils, plumbing goods, electrical fixtures and appliances, reflectors, hub caps, automotive accessories, and numerous other parts.

Toggle slide, vertical and cross slide adjustments permit quick set ups when changing from one job to another. Additional accessory equipment can be furnished for finishing an unusual variety of out-of-round parts as well as cylindrical work.

CATALOGS ON REQUEST

ROTARY STRAIGHT LINE SEMI-AUTOMATIC AND SPECIAL *Polishing and Buffing* Machinery

SPECIAL MACHINES AUTOMATIC BUFFING MACHINES

ACME *Manufacturing Co.*

1400 E. 9 MILE RD., DETROIT 20 (Ferndale) MICH.

Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR NEARLY HALF A CENTURY

MISCO *Precision* CASTINGS

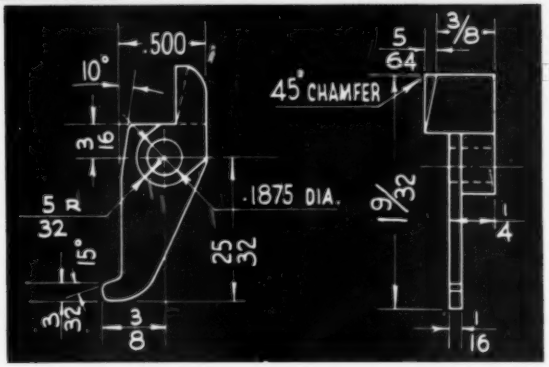
CARBON AND STAINLESS STEEL

CAST TO MICROMETER TOLERANCES

Part:

ROTOR WINDING PICKUP FINGER

Alloy: Miscrome 5
Weight: 0.24 oz.
(A.I.S.I. Type 440 Modified)



This intricate casting is used in the production of automotive generators and starters. The adoption of precision castings resulted in a cost saving of 94% on this part.

THIS STAINLESS STEEL PICKUP FINGER is an excellent specimen of a Misco Precision Cast part. Misco possesses important advantages for the quantity production of pieces such as this, which are intricate from both design and dimensional standards. Misco has superior quality alloys to fit your need; high strength hardenable, wear resisting, heat and corrosion-resisting steels. Misco has extensive technical experience and adequate facilities to assure prompt delivery. Misco Precision Castings can be adapted to your products and manufacturing demands. Investigate the Misco Precision Casting Process for low-cost processing of hard-to-make metal parts in metals and alloys that must resist heat, abrasion and corrosion. Our Engineering Department is ready to assist with your design, manufacture and material problems.

PRECISION CASTING DIVISION
Michigan Steel Casting Company

One of the World's Pioneer Producers and Distributors of Heat and Corrosion Resisting Alloys

1999 GUOIN STREET • DETROIT 7, MICHIGAN

MISCO
Heat and Corrosion Resistant Alloys

How long will this valve last?

Hoskins Chromel-Alumel thermocouple alloys accurately register exhaust temperatures of jet aircraft engines.

Heating elements made of Hoskins Chromel give long life service in industrial electric furnaces, home appliances.

Hot stuff for hot jobs! Hoskins Alloy 502 is widely used by industry for many heat resistant mechanical applications.

You're looking in on a life-saving operation . . . one that's being performed on an engine valve. Not an ordinary valve for an ordinary engine. But a valve destined for long, hard service in an aircraft, tank, or heavy-duty truck engine. A valve that must be made to stand up under extremely severe operating conditions . . . high temperatures, for long periods of time, plus the destructive corrosive action of hot exhaust gases.

And what's responsible for long valve life under such gruelling conditions? Nothing less than Hoskins Alloy 717 . . . a closely controlled nickel-chromium composition developed especially for just such tough and vital service. It's highly resistant to heat . . . immune to the corrosive atmospheres created by combustion of high octane fuels. What's more, it's readily applied by fusion to form a non-porous protective facing over the basic valve forging.

But 717 is only one of several specialized nickel-chromium alloys developed and produced by Hoskins. Among the others: Alloy 502 . . . known throughout industry for its dependability on a wide range of heat resistant mechanical applications. The Chromel-Alumel thermocouple alloys . . . unconditionally guaranteed to register true temperature–E.M.F. values within specified close limits. Spark plug electrode alloys which have become universally accepted standards of quality and durability. And, of course, there's Hoskins CHROMEL . . . the *original* nickel-chromium resistance alloy used as heating elements and cold resistors in countless different products.

HOSKINS

MANUFACTURING COMPANY

4445 LAWTON AVENUE, DETROIT 8, MICHIGAN

Chromel® NICKEL CHROMIUM WIRE

Metal Progress

Taylor Lyman, *Publisher*

A. P. Ford, *Sales Manager*

George H. Loughner, *Production Manager*
7301 Euclid Ave., Cleveland 3—UTah 1-0200

District Managers

John F. Tyrrell and John B. Verrier, Jr.
55 W. 42nd St., New York 18—CHickering 4-2713

Ralph H. Cronwell
482 Burton Ave., Highland Park, Ill.—Highland Park 2-4363

Donald J. Billings
7301 Euclid Ave., Cleveland 3—UTah 1-0200

PUBLISHED BY AMERICAN SOCIETY FOR METALS, 7301 EUCLID AVE., CLEVELAND 3, OHIO—W. H. EISENMAN, SECRETARY

• Index to Advertisers •

Acheson Colloids Corp. 109
Acme Manufacturing Co. 181
Air Reduction Sales Co. 6
Ajax Electric Co. 5
Ajax Electrothermic Corp. 41
Ajax Engineering Co. 145
Ajax Manufacturing Co. 179
Aldridge Industrial Oils, Inc. 136
Allied Research Products, Inc. 106
Alloy Engineering & Casting Co. 161
Alloy Precision Casting Co. 131
Alloy Rods Co. 128
Aluminum Co. of America 38-39, 174
American Brass Co. 2, 112A & B
American Chemical Paint Co. 116
American Gas Furnace Co. 178
American Machine & Metals, Inc. 16
American Metaseal Corp. 23
American Non-Gran Bronze Co. 131
American Rack Co. 133
American Roller Die Corp. 141
Ames Precision Machine Works 92
Amplex Manufacturing Co. 160
Applied Research Laboratories 31
Arcos Corp. 126-127
Armour & Co., Ammonia Division 110
Ashworth Brothers, Inc. 172

Baird Associates, Inc. 124
Baker & Co., Inc. 132
Barber-Colman Co. 140
Barrett Division,
Allied Chemical & Dye Corp. 150
Bausch & Lomb Optical Co. 80D
Bell & Gossett Co. 164
Belmont Smelting & Refining Works, Inc. 28
Beryllium Corp. 34
Bethlehem Steel Co. 119, 163
Bidle Co., W. S. 136
Birmingham Committee of 100 102
Boder Scientific Co. 140
Bristol Co. 152-153
Buehler, Ltd. 33
Burrell Corp. 18

Carborundum Co. 26
Carl-Mayer Corp. 136
Carlson, Inc., G. O. 104
Carpenter Steel Co. 10
Case Hardening Service Co. 135
Chase Brass & Copper Co. 160B
Chicago Steel Foundry Co. 178
Christiansen Corp. 11
Cities Service Oil Co. 123
Clark Instrument, Inc. 154
Cleveland Crane & Engineering Co. 141
Cleveland Electric Laboratories Co. 136
Climax Molybdenum Co. 162
Cold Metal Products Co. 32B
Columbia Electric Mfg. Co. 172
Commercial Steel Treating Corp. 137
Copperweld Steel Co. Back Cover
Crucible Steel Co. of America 13

Dahlin Co., C. A. 142
Daniels Plating Barrel & Supply Co. 133
Darwin & Milner, Inc. 141
Delaware Tool Steel Corp. 122
Despatch Oven Co. 9
Detrex Corp. 132
Detroit Testing Machine Co. 140
Dice Co., J. W. 139
Dietert Co., Harry W. 27
Distillation Products Industries 14
Dow Chemical Co. 35
Dow Furnace Co. 156
Drever Co. 138
Driver-Harris Co. 45
duPont de Nemours & Co., Inc. 160B

Eastman Kodak Co. 97
Eberbach Corp. 180
Ekstrand & Tholand, Inc. 142
Electric Furnace Co. Inside Back Cover
Electro Alloys Co. 1
Electro Metallurgical Division,
Union Carbide & Carbon Corp. 89
Engineered Precision Castings Co. 131
Erico Products, Inc. 143

Firth-Sterling Steel & Carbide Corp. 117
Fisher Scientific Co. 175
Foxboro Co. 101

Gas Appliance Service, Inc. 174
Gas Machinery Co. 96
General Alloys Co. 169
Gordon Co., Claud S. 158, 162
Great Lakes Steel Corp. 103
Grieve-Hendry Co., Inc. 135
Gulf Oil Corp. 30

Hangsterfer's Laboratories, Inc. 141
Haynes Stellite Co.,
Union Carbide & Carbon Corp. 151
Hays Corp. 136
Hevi Duty Electric Co. 108
Holcroft & Co. 32
Hones, Inc., Charles A. 180
Hooker Electrochemical Co. 167
Hoskins Manufacturing Co. 163
Houghton & Co., E. F. 113

Illinois Testing Laboratories 118
Imperial Plating Rack Co. 133
Industrial Heating Equipment Co. 134
Inland Steel Co. 50
International Nickel Co., Inc. 80A, 177
Ipsen Industries, Inc. 22

Jarrell-Ash Co. 148
Jessop Steel Co. 168A
Johns-Manville 41
Johnson & Son, Inc., S. C. 165

Kasenit Co. 136
Kemp Manufacturing Co., C. M. 142
Kennametal, Inc. 151
Kent Cliff Laboratories 140
King, Andrew 178
Korn, Inc., Wm. 143

Lakeside Steel Improvement Co. 138
LaSalle Steel Co. 15
Lavin & Sons, Inc., R. 8
Leake Stamping Co. 143
Lebanon Steel Foundry 27
Leeds & Northrup Co. 3, 170
Leitz, Inc., E. 172
Lindberg Engineering Co. 42
Lindberg Steel Treating Co. 137
Linde Air Products Co.,
Unit of Union Carbide & Carbon Corp. 93
Little Falls Alloys, Inc. 142
Livingstone Engineering Co. 132

Magnethermic Corp. 134
Magnetic Analysis Corp. 159
Magnus Chemical Co. 25
Mahon Co., R. C. 24
Manhattan Rubber Div.,
Raybestos-Manhattan, Inc. 131
Martindale Electric Co. 154
Maurath, Inc. 143
Medart Co. 30
Meriam Instrument Co. 139
Merrill Brothers 122
Metallizing Co. of America 174
Michigan Steel Casting Co. 182
Midland Industrial Finishes Co. 21
Milne & Co., A. 28
Minneapolis-Honeywell Regulator Co.
(Industrial Div.) 46-47, 173
Mitchell-Bradford Chemical Co. 160
Molybdenum Corp. of America 166
Morrison Engineering Co. 134

National Carbon Div.,
Union Carbide & Carbon Corp. 33
National Forge & Ordnance Co. 146-147, 176
National Machinery Co. 40
National Rack Co., Inc. 133
National Spectrographic Laboratories, Inc. 139
Newage International, Inc. 28
Niagara Alkali Co. 36
North American Manufacturing Co. 135
Northrop Aircraft, Inc. 180
Norton Co. 48

Ohio Seamless Tube Co. 99
Olsen Testing Machine Co., Tinius 168

Pearson Industrial Steel Treating Co. 137
Pereny Equipment Co. 135
Peters-Dalton, Inc. 133
Peterson Steels, Inc. 28
Picker X-Ray Corp. 145
Pike and Co., E. W. 140
Pittsburgh Commercial Heat Treating Co. 138
Pittsburgh Plate Glass Co. 176
Pressed Steel Co. 4
Purdy Co., Inc., A. R. 142
Pyrometer Instrument Co. 176

Raybestos-Manhattan, Inc. 131
Reliable Steel Co. 141
Republic Steel Corp. 95
Revere Copper & Brass, Inc. 91
Richards Co., Inc., Arklay S. 156
Rigidized Metals Corp. 142
Rolock, Inc. 111, 132

Saunders & Co., Alexander 180
Seal-Peel, Inc. 133
Sentry Co. 98
Sharon Steel Corp. 80C
Sherman Industrial Electronics Co. 134
Solventol Chemical Products, Inc. 133
Spencer Turbine Co. 149
St. Joseph Lead Co. 42
Standard Alloy Co. 135
Standard American Engineering Co. 32A
Standard Steel Treating Co. 137
Steel City Testing Machines, Inc. 158
Stuart Oil Co., D. A. 94
Superior Steel Corp. 160A
Surface Combustion Co. Inside Front Cover

Timken Roller Bearing Co. 159
Topper Equipment Co. 132

United States Testing Co., Inc. 139
Upton Electric Furnace Co. 134

Vanadium Corp. of America 165
Vincent Steel Process Co. 137

Wagner Mfg. Co. 143
Westinghouse Electric Corp. 7, 37, 120-121
Wheelco Instruments Co. 157
Wheelock, Lovejoy & Co., Inc. 144
White Metal Rolling & Stamping Corp. 142
Wilson Mechanical Instrument Co. 125
Wisconsin Steel Co. 155
Wyman-Gordon Co. 107

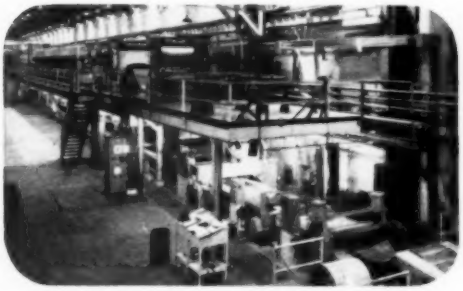
Youngstown Sheet & Tube Co. 144

Zia Steel & Wire Co. 25

TOWER PRESS
CLEVELAND

Galvanizing
Aluminizing
Bright Annealing and
Normalizing Strip ------ Continuously

Strip in single or multiple strands up to a total width of 54" may be bright annealed or normalized, continuously, in this EF gas fired radiant tube installation. Capacity 7200 lbs. per hour.



A large capacity continuous strip normalizing, annealing and galvanizing unit. This is a combination EF gas fired radiant tube and electrically heated installation and is over 400 feet long.

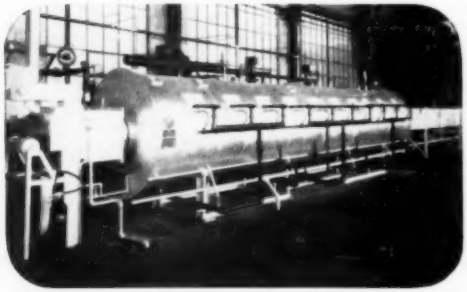
We are in position to design, build and put in operation: continuous strip lines for hot or cold rolled, high or low carbon, stainless, silicon, tinplate, aluminum, brass, bronze or any other ferrous or non-ferrous strip—for bright annealing, normalizing, galvanizing, aluminizing, tinning or any other process—in the size and type best suited to your plant, process, product or production requirements. No job is too large or too unusual.

Put your production furnace problems up to experienced engineers—*it pays.*

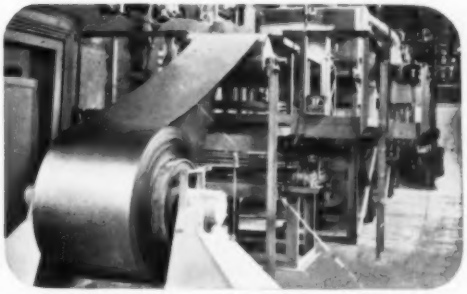
THE ELECTRIC FURNACE CO.

Salem • Ohio

Gas Fired, Oil Fired and Electric Furnaces



Stainless steel strip is bright or process annealed, continuously, in this EF gas fired special atmosphere tube muffle type furnace. It also handles other strip requiring lower temperatures.



An EF special atmosphere furnace with flame preheating, burn-off or oxidizing section, and controlled heating and cooling zones for producing various surface conditions on strip.

The Symbol of Quality

ARISTOLOY STEELS

in

ELECTRIC FURNACE STEELS

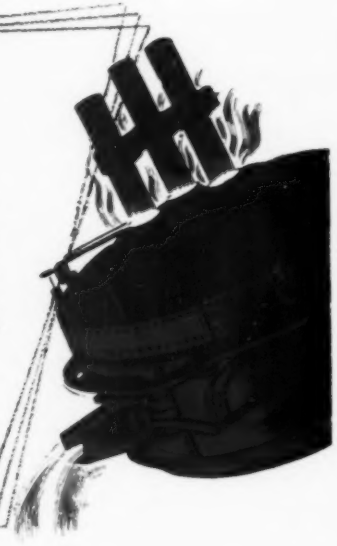
STANDARD STRUCTURAL ALLOY • BEARING QUALITY • ALLOY TOOL • SPECIALTY • NITRALLOY • CARBON TOOL • MAGNAFLUX-AIRCRAFT QUALITY

Hot Rolled • Forged • Annealed • Heat Treated • Normalized
Straightened • Cold Drawn • Machine Turned • Centerless Ground

COPPERWELD STEEL COMPANY

WARREN, OHIO

117 Liberty Street New York, New York	1578 Union Commerce Bldg. Cleveland, Ohio	528 Fisher Building Detroit, Michigan
176 W. Adams Street Chicago, Illinois	7251 General Motors Bldg. Detroit, Michigan	3104 Smith Tower Seattle, Washington
P. O. Box 1633 Tulsa, Oklahoma	325 W. 17th Street Los Angeles 15, Calif.	Monadnock Building San Francisco 5, Calif.
	1140 Lockwood Drive Houston 20, Texas	803 Loew Building Syracuse, New York

sell your scrap

IT'S BETTER TO USE THE BEST!